ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXXI, No. 14.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.... 273, 280
The Bartissol Plan for Finishing the Panama Canal 274
The Construction of a Short Tunnel; W. Va. & P. R. R. (illustrated)..... 274
Wire Glass 276
Stand-Pipe Accidents and Failures..... 276
Tests of a Stirling Boiler..... 277
International Standards for Testing Iron and Steel 277
A Flywheel Pumping Engine for Heavy Pressure (with inset)..... 278
Geyelin-Jonval Turbines (illustrated)..... 278
An English Sewer-Pipe Joint (illustrated)..... 285
Notes by Rail..... 285
The Peoria Stand-Pipe Failure..... 285
PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS 280, 281
EDITORIAL NOTES..... 282
Importance of Tight Joints for Sewers—The Publication of Expired Patents in the "Official Gazette"—Corporate and Private Ownership of Tramway Lines—Stand-Pipe Failures.
EDITORIAL:
The Bearing Power of Piles..... 283
LETTERS TO THE EDITOR..... 284
Movement of Track on a Street Railway—Clamp Molds for Pouring Lead Joints—Signal-Ladies—An Automatic Shut-off for Stand-Pipes (illustrated)—The Metric System—The Expansion of Ice.
CONSTRUCTION NEWS..... 289-292
Railways, Street and Electric Railways, Elevated and Cable Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewers, Streets, Electric Light and Power, Contract Prices, Miscellaneous Contracts and Supplies.

A shearing machine for cutting up old ties has been built for the Pittsburg, Fort Wayne & Chicago R. R. by the Murphy Foundry Co., of Alliance, O., and is found to be very satisfactory, saving much labor in cutting up ties for fuel. The blades are about 8 ins. wide and there is a clearance of about 1 in. between the blades, so as to allow of old spikes, etc., dropping through. The machine is driven by a belt wheel, and runs at about 20 strokes per minute, cutting about 120 cords of wood per day from old ties and telegraph poles. The pieces are crushed in cutting so that they can easily be split lengthwise with an axe.

The Navy Department test of machine guns of small caliber, using only smokeless powder and jacketed bullets, is called for May 1. Guns submitted for trial must be delivered before that date to the commandant of the Washington Navy Yard, together with 10,000 rounds of suitable ammunition for each gun. Samples of the ammunition, taken at random and tested in an infantry rifle, must show a velocity of not less than 1,950 ft. per second. All guns will be tested by rapid firing without aim, and target firing at moderate range will test rapidity and accuracy of aim. This trial is to decide the type of gun to be used in the navy, though the Department may adopt two types of guns.

The Corinth ship canal, according to a late report made to the Austrian Lloyds, is not yet in first-class orded for traffic. At certain points in the canal the danger from landslips is still present, notwithstanding the masonry put in at these weak places. At the west end of the canal 23 ft. is the maximum permissible draft for ships entering. No lights are provided and night passage through the canal should be avoided except in a clear night and with no wind blowing. The canal company has provided no means for rendering assistance to ships aground. The report goes on to say that, while there should be no special difficulty in making the passage from April to November, it should be made in the day time.

Compressed air is being conveyed through a 2-in. pipe for 18 miles on the Harlem Division of the New York Central R. R., supplying air for interlocking plants, automatic signals, small engines for running dynamo, blacksmith forges, etc., the source being a compressor at one end of the line, with another for emergencies near the other end. The loss of pressure at the opposite end of the line from where the compressor is located is only about 15%. The pressure at compressor never exceeds 80 lbs. and most frequently the gage shows 75 lbs.

An electric car lighting system is being tried on a car of the Chicago, Milwaukee & St. Paul Ry. The machine is independent for each car, and is driven from one of the axles, and geared from the axle to the dynamo at a ratio of 3 to 1. The dynamo is 1 HP., and wound to give a current of 28 volts and 40 amperes. An electrical switch automatically changes when the direction of the car is reversed, so that during the backward movement of the train the light remains steady. A system of storage batteries provides for a steady continuation of the light during stops of the train, and will run the lamps for five hours after the car has stopped. The apparatus is the invention of W. Biddle, of Brooklyn, N. Y., and is controlled by the American Railway Electric Light Co.

The most serious railway accident of the week was a head collision of freight trains March 28, near Oxford, Miss. Both engines and several cars were wrecked, and two men were killed.

A wooden bridge 300 ft. long crossing Connelly's River, at Radford, Va., collapsed March 30. The structure was being removed to make way for a steel bridge. Three men were killed and four seriously injured.——A floor beam connection on the Main St. bridge over the Miami River, at Dayton, O., broke on March 31, and traffic had to be suspended until repairs were made. The bridge was built in 1870.

A water-works stand-pipe, at Peoria, Ill., burst and fell on March 30, and the flood caused considerable damage. One man was killed and several were injured, three fatally. A full report of the accident is given in another column.

The effect of flushing open sewers, concerning which few tests have been made in a scientific manner, is now being investigated by two resident graduates of Cornell, with probability of success. The object is to determine how far the effect of flushing will be felt in sewers of various sizes, and also how far apart the gates or tanks must be placed to obtain the desired results in reference to the quantity of flushing water, the diameter of the sewer and its grade. Preliminary experiments have been conducted upon an open channel of considerable length provided with a gate; and by electrical devices the instant at which the front of the wave reaches various points of the sewer is recorded; also, the depth of the advancing wave and the water depth and velocity at every 10 ft. of length of the sewer; also in some of the experiments the water is colored so that it tells its own history upon a long strip of paper, as it flows down grade. Experiments are also being conducted in the laboratories upon the resistance to the flow of water through orifices of all kinds, varying in sizes, and under heads up to 300 ft.

The "brick battleship Illinois," a notable feature of the late Columbian Exposition, is to be removed to a new site at the foot of Van Buren St., Chicago, seven miles away from its present position. This model battleship is 348 ft. long, 69¼ ft. beam, with the hull built of brick, steel, wood and concrete, resting upon piles. Mr. F. W. Grogan, the naval architect who built the "Illinois" originally, will superintend the removal. He proposes to float the ship upon 13 pontoons or floats, each 80 ft. long, 24 ft. beam and 6½ ft. deep. These will be arranged in three lines, one under the axes of the ship and a line on each side. To get the center row of pontoons in place, the deck will be trussed along the center and the three central rows of piles will be cut away. The floats, ballasted with water, will then be towed into position and solidly joined into three pontoons by timbers. Long timbers or trusses will then be passed under the ship and will rest on blocking on the three lines of pontoons. Everything being ready the pontoons, which have then only about 2 ins. of freeboard, will be pumped out by a system of pipes connected with powerful steam pumps, and the structure, weighing 1,600 tons, will finally be lifted. The floats and ship will then be towed to Van Buren St. and floated over the new foundation and the ship will be settled down upon it by admitting water again to the pontoons.

The Love underground trolley system has now been successfully used by the Rock Creek Railway Co., in Washington, D. C., for over one year. It was the outcome of Congressional action forbidding the use of overhead wires in the city, and yet requiring the company to operate about 1½ miles of their road in the city. The overhead wires are used for six or seven miles up to the line, and a halt of 10 seconds is sufficient for the transfer to the underground system. Hon. F. G. Newland, President of the company, says that the line works well, and in the last winter was not disabled when the overhead portion was put out of service by a severe storm. The wire is thoroughly protected and is yet easily accessible, and the cost of a new system is estimated at from $35,000 to $40,000 per mile. Mr. Newlands thinks that the damage to insulation, usually ascribed to dampness in the conduit, really results from contraction and expansion in the wire. Consequently these conduit wires are in about 600-ft. lengths with the insulators supported in jaws which move longitudinally with the wire. At the end of each section the wire is held by powerful springs which keep it at a constant tension and make of it practically a tram-rail for the trolley.

The watering carts of Malden, Mass., are made to do duty as road-rollers by using broad tires, with the gage of the forward pair of wheels set so as to come inside the track of the hind wheels. This is a practice which could be followed with advantage in other vehicles passing over country roads. Instead of cutting up the roadway with narrow tires, heavily loaded and following in the same track, every heavy wagon could be made a road roller of very considerable value, with a material reduction in the cost of road maintenance.

St. Louis water mains are being corroded by electric ground currents. The first serious injury was discovered on March 28. A 6-in. iron main was discovered with a section badly corroded by the return current of the St. Louis & Suburban Ry. It is supposed that other places on the mains have been similarly injured and that leaks will develop soon.

An automatic sound signal, operating in connection with the semaphores of an ordinary block system, and sounding inside the cab, is being tried on the Tottenham & Forest Gate Railway, near London. The device is the invention of Mr. G. N. Abernethy, and Mr. I. A. Timmis, the latter being the inventor of the automatic electric signal system on the Liverpool elevated railway. A wire brush attached to the engine makes contact with a bar placed between the rails. As the engine passes a signal, that signal is repeated on the engine, an indicator pointing to "line clear," or to "danger," and one of two bells being rung. At the same instant an index in the cabin gives a corresponding signal, so that the signalman not only knows that a locomotive has passed a particular signal, but he also knows that the engineman has been correctly informed of its position. The two instruments, in the cabin and on the locomotive, are in series, and so must give the same indications. The same wire also serves to work an electric repeater in the cabin, to show at all times the position of the signal. The apparatus is quite simple. On the signal post is a reversing switch, which puts the zinc or copper pole of a local battery to the line, according to the position of the signal. This line divides at the cabin; one part passes through the repeater in the cabin, and thence to earth; another part goes through the tell-tale instrument to an insulated contact several feet in length, aranged between the rails near the signal. When the brush on the engine passes over the contact bar a circuit is completed from the signal-post, through the tell-tale in the cabin, through the contact to the locomotive indicator, thence to earth. The indicator on the locomotive rings the bell by means of a relay and local battery. The circuit is closed at the signal by a "two-way" switch. Turned one way when the arm is lowered it sends the current in the positive direction, reflecting a polarized needle to the right to "track clear"; turned the reverse way, when the blade is horizontal, it sends a negative current throwing over the needle to "stop." The negative current rings a bell, while the positive one sounds a gong.

English locomotive builders are complaining that their business is steadily decreasing, and one reason for this, as we have pointed out before, is undoubtedly the fact that they do not sufficiently consider the conditions of the railways for which they build engines. Our English contemporary "Transport," puts the case very clearly as follows:

> The bitter cry of the British locomotive builder that his trade is fast dying has been heard more than once of late. What orders there are nowadays are not coming to England, but going to the American builders. The reason may, I think, be given in an extract from a letter written home from Central America some three years back (when the English builders were blocked with orders) by a very competent observer, a railway man and an Englishman. "Unless our English locomotive builders wake up they will lose all the trade in these new countries. They have no imagination and build a locomotive as if it were intended for the Northwestern or Great Northern roads, as rigid as a poker, and they don't even send men out to see what such roads need. Then they are still sending out cars, etc., not fitted with the Westinghouse brake. Our engineers are really 20 years behind time." When one sees in countries such as Holland and Italy that all the old engines are English, while the new engines are French or Swiss, or German, it is difficult to believe that it is not our own fault which has lost us the neutral markets.

A large party of engineers residing in New York city and vicinity visited the works of the Ball & Wood Engine Co., at Elizabethport, N. J., on the afternoon of March 31 to see the new 600-HP. vertical engine, which the company has just completed for the Chicago Edison Co. The engine is of novel design, and will shortly be illustrated in these columns.

THE BARTISSOL PLAN FOR FINISHING THE PANAMA CANAL.

The scheme of M. Bartissol for completing the Panama Canal is set forth at full length in a late issue of "La Revue Technique," and from it the following general points are taken:

M. Bartissol shows the various plans for a lock canal at this point, projected since the collapse of the sea level project. The chief feature of his plan is that he proposes to have only four locks in all, or two pairs at the ends of a central level with a water surface 75 ft. above sea level. The other projects necessitated eight and ten locks with 122 ft. to 175 ft. above tide for the highest level.

The lower level of the Bartissol plan of course means the removal of a much greater cube of material, and it is for the economical disposal of this material that he offers the following plan: He would first control the waters of the upper Chagres by dams and reservoirs, and lead the water in an open channel to the line of the canal. Then, commencing at the level of the bottom of the canal, he would build a conduit parallel to the canal and inside the side slope of the finished bank, about 33,000 ft. long, and falling rapidly to the Pacific. This circular conduit would be 13 ft. in inside diameter, lined with cement beton, and have a uniform fall of about 1 ft. in 1,000 ft. This channel would be partly in tunnel; in masonry and possibly in metal. Leading into this outlet channel would be shafts from the excavations to be made, and through these shafts the debris would be thrown into the channel, and the quantity and velocity of the flow from the Chagres River would be depended upon to convey this material to the Pacific. The engineer figures that a velocity of flow of 10 ft. per second would be secured, and that this was sufficient for the purpose proposed. It should be mentioned that the grade in the discharge channel is uniform from point of beginning to the sea, and that the 13-ft. conduit is to be filled through 10 ft. of its height.

M. Bartissol calculates the duty of the conduit at 30 cu. m. per second of water from the Chagres, or about 1,000,000 cu. m. in a day of 10 hours. With 100 shafts and 400 cu. m. of debris thrown into each, the day's work would represent a cube of 40,000 cu. m. of debris, or only about 4% of the total volume of flow. In figuring the transporting capacity of the conduit, he uses the experiments of Guillemain and Durand-Claye as a basis. According to these authorities a velocity of 0.5 ft. per second would carry the heavier clay; 0.65 ft. would transport fine sand; 2.28 ft. would handle small gravel, and 5.86 ft. per second would transport flat stones. M. Durand-Claye says that a velocity of 5.31 ft. per second will transport stones 4 ins. in diameter, and 7.5 ft. would carry stones 8 ins. in diameter. Engineer-in-Chief Duponchel is quoted as stating that in his own experience, verified by an official commission, a stream of water with a velocity of from 6.5 to 10 ft. per second carried almost 23% of its own volume in rock material, and that large stones of all dimensions were carried with it. M. Duponchel claims that in a conduit of circular section and uniform slope the material carried by a current of sufficient velocity would not only be carried forward by rolling, but would be in a state of complete suspension in the fluid vein, and that there would be really little friction on the sides of the canal. Experiments made at the Culebra cut, at Panama, also showed that a 20 in. pipe, with a velocity of 7.8 ft. per second, carried for eight continuous days one-third of the volume of water in debris; and stones $4 \times 4 \times 8$ ins. were carried with a velocity of 7.3 ft. per second. These experiments, says M. Bartissol, give confidence in the working of the conduit.

M. Bartissol figures out from these data that he could complete the necessary work on the canal in four years at an expense of about $100,000,000.

The Panama Canal liquidators, MM. Gautron and Monchicourt, carefully review M. Bartissol's proposition. They say that his whole proposition is founded upon the rate of speed and facility with which he proposes to remove the material, and they doubt not but that for fine material his plan would work well enough. But, unfortunately, all kinds of material are met with in the Culebra cut; strata of sand and hard clay, green tufa, schistose and metamorphic rock with volcanic interstratifications, etc. Beds of hard clay are found, filled with pebbles, that only dynamite can move, though on exposure to the air these masses will fall to pieces in a few weeks. The borings made do not reach the ground M. Bartissol proposes to remove, and consequently no one can tell what material may be met with. It is possible also, say the liquidators, to choke the conduit at the bottom of the wells. They conclude that the transporting capacity of the conduit is purely conjectural, without precedent in practice, except in the handling of auriferous gravel. They do not agree with the statement of the authorities quoted that there would be a continuous flow of material practically carried in suspension; but say that the forward movement would be chiefly by rolling, and would be intermittent in action. With all the economies of M. Bartissol's project, there are coupled very grave uncertainties, and the liquidators do not see that the plan would afford that degree of security necessary to induce them to approve of it, either as to time of execution or in expense. As M. Bartissol proposes to pass 32,000,000 cu. m. of material through his conduit, this mass would rapidly wear out the sides of the channel, and the irregularities produced would act injuriously upon the flow of its contents. M. Bartissol proposes also to leave this conduit after the completion of the canal, as a great longitudinal drain, but the liquidators vigorously object to this use as an ever-impending danger to the canal and to traffic.

THE CONSTRUCTION OF A SHORT TUNNEL; W. VA. & P. R. R.*

By J. G. G. Kerry, A. M. Can. Soc. C. E.

The West Virginia & Pittsburg R. R., a feeder of the B. & O. system, was built to open up central West Virginia. The country shows a series of heavy narrow parallel ridges with deep dividing valleys. At the divide between the Little Kanawha and Elk River valleys, it was found impossible to locate over the summit while maintaining the desired maximum grade of 1.5%, and the tunnel whose construction is described in this paper was needed to pass this point. The railway was built by the West Virginia Improvement Co., of which Mr. J. A. Fickinger was Chief Engineer and Manager, and the contract for this work was let in January, 1891, to T. J. Steers & Co., of Weston, W. Va.

The line passes through the north approach cut and into the tunnel on a 7° 30′ curve, the P. T. of which lies some 40 ft. beyond the portal; the remainder of the tunnel and the south approach cut are on tangent. The tunnel is on a 0.25% grade falling to the south, and is on the summit between two 1.50% grades. The portals were laid out so that the cut on center line at the head of the portal slope would be 50 ft., the distance between them being 624 ft.

The material was a soft blue clay shale, nearly dry, and showing little stratification. It rapidly disintegrated on exposure to the air, and tunneling through it without timbering would have been dangerous, if not impossible. The company not being required to line the tunnel throughout with masonry at the time of construction, it was necessary to use a system of timbering amply strong for several years' service and large enough to contain the masonry when it should be built. An unusually large excavation section (18.77 cu. yds. per lin. ft.) was rendered necessary by this double lining. The width was 23 ft.; height, from floor to springing line, 13 ft.; semicircular arch of 11 ft. 6 ins. radius. The area of heading was 207.75 sq. ft.; bench, 299 sq. ft.; total, 506.75 sq. ft. The shale was overlaid with beds of heavy and strong sandstone dipping slightly toward the north and so low that near the north portal some of the sandstone had to be blown down to make room for the timbering.

The excavation was all done by hand work, no special tunnel machinery being employed, and it was conducted on the general principle that nothing is so expensive in tunneling as a cave-in.

The shifts were divided into heading and bench gangs, the foreman of the bench gang being, however, subject to directions from the foreman of the heading. The heading gang consisted of a foreman, eight miners, six muckers and a "nipper;" and its work was to excavate the material from the bottom of the wall-plates up (7.70 cu. yds. per lin. ft.), to place the wall-plates in position, to erect the arches upon them, and to lag and pack the same. Coming back into the heading after a blast, the miners first pulled down all dangerous material from the roof, then cleared away enough of the debris of the blast to give themselves working room, and proceeded with the drilling.

*Condensed from a paper read March 15 before the Canadian Society of Civil Engineers.

Three sets of holes (two wet and one dry) were usually drilled in the face of the heading; each set consisting of four holes about 4 ft. deep, the exact placing of each hole depending on the success of the last shot; 24 lin. ft. of hole was considered a day's work for two miners. The holes were loaded with from 4 to 6 sticks (⅓ lb.) of dynamite apiece, and fired by battery or fuse. As far as practicable, all blasts were fired at the end of the five-hour spells, so that the dynamite fumes might dissipate during the idle hour. The average fall from a heading blast was 2½ ft.

While the drilling was progressing, the muckers cleaned up the heading, the scaffold car, Fig. 1, being necessary for this purpose. This was a mounted platform, with height a little lower than the heading floor, and with its frame so arranged that dump cars could run right under it and be loaded through shoots from the platform above. It ran on a special track, and was provided with long detached planks which were laid from the platform onto the heading floor, the muck being wheeled down them and dumped through the shoots. The car was provided with a small derrick for handling timber, lagging and packing.

The bench gang consisted of a foreman, eight drillers, ten muckers and a "nipper;" and its work was to excavate the material remaining in the section (11.07 cu. yds. per lin. ft.), to place the plumb posts, and to lag and pack behind them. After a bench blast, the whole gang was put at work cleaning off the rails of the scaffold car track, and pushing this up as way was made for it, it being always run back for safety before a blast. When the scaffold car was brought far enough ahead to communicate with the heading, the drillers cleared off places for their new set of holes, and went to work on them. The bench was shot down in 4 ft. holds, two half-depth blasts being made for each hold; each blast consisted of four holes, two being center holes and two drilled as nearly vertically under the inside edge of the wall-plate as possible; the charges were 10 sticks of dynamite to an outside hole and 15 to a center one. The drilling and blasting of the bench, though simple, required skillful management, the points to be guarded against being: damage to plumb posts and arch timbers, danger of uncovering too great a length of the wall-plate at a single shot, and complete avoidance of any interference with the progress of the heading.

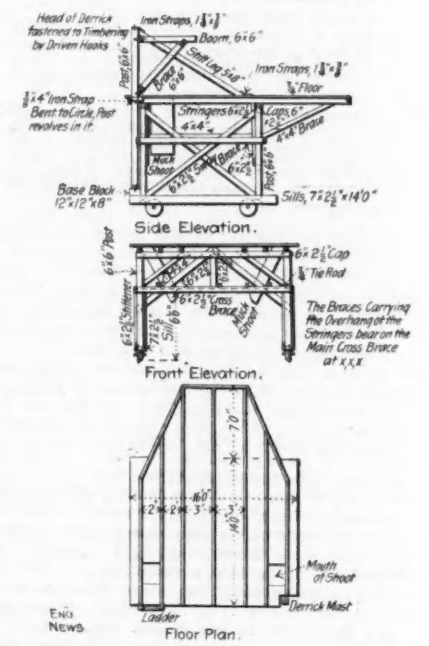


Fig. 1. Scaffold Car for Tunnel.

The bench was taken out to the dump in side-dump cars of about 1 cu. yd. practical capacity run in trains of two, the heading muckers loading one through the scaffold car shoots, while the bench men loaded the other, the bench men having to clean up to the face of the bench before the next blast was ready. Where the rock shot down in large masses, progress was much aided by the use of stone flats, mounted so that the platforms were flush with the tops of their wheels, onto which heavy rock could be barred without blockholing or extra handling. The bench was kept about two wall-plate lengths behind the heading, and made the same average progress. This progress was about 2½ ft. per shift; the actual excavation was made at a rate of 5 ft. per shift, but the time consumed in pointing down odd projections, timbering, lagging and

packing being equal to that spent on rough excavation, the progress rate was only 2½ ft. per shift.

The north heading was started April 17, the south heading being delayed by a heavy approach cut until June 3. No record was kept of the monthly progress, irregularities of the forces and delays occasioned by lack of timber rendered all such records valueless. The headings were holed on Sept. 17, and the bench was finished by Oct. 15, the work having been in progress for just six months. The heading was driven with great care, and no exceptional record was made until the night before the holing, when two gangs

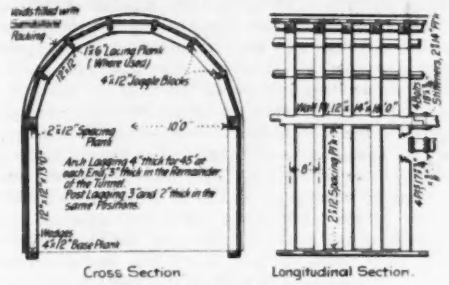


Fig. 2. Tunnel Timbering.

drove 20 ft. of heading of rapidly diminishing cross-section in a desperate effort to pierce the 24 ft. remaining in the tunnel. The driving of the bench was of course limited by the heading, but after its completion the pick of the forces were placed on the bench, and with gangs increased to one foreman, eight drillers, twelve muckers and nipper, the rate of progress rose to 3½ ft. per shift, the bench being blown in 6 ft. holes.

No trouble was experienced with the bench anywhere, but the heading was frequently in bad ground. At the north portal the top of the heading passed into a shattered bed of sandstone rock, which could not be shot down without disturbing a considerable amount of material on the portal slope. Here a 6×8-ft. drift was made under the sandstone, and the heading expanded to its full section and timbered at the second wall-plate, and the first wall-plate length was driven outwards, the shattered rock being caught up by timbers as quickly as the excavation was completed. As the tunnel grade fell and the sandstone rose to the southward, the heading was soon clear of the sandstone, which made an admirable roof for a season. The shale had very little adhesion to the sandstone, and when the sandstone bed and the tunnel section separated, it soon proved itself not sufficiently strong to hold up across the span by coming down in heavy falls, which left the bottom of the sandstone exposed. The material between the bottom of the sandstone and the top of the section was accordingly excavated, until its thickness grew such that the cost of its removal became an item of considerable expense when it was determined to hold it in place. This material where removed was classified as "fallen material."

Up to this point the system had been to drive a full heading for a wall-plate length, and then timber it up. This was now changed, and the heading was driven with an arched longitudinal section having full height at the end of the preceding wall-plate, and being barely high enough at the end of the new wall-

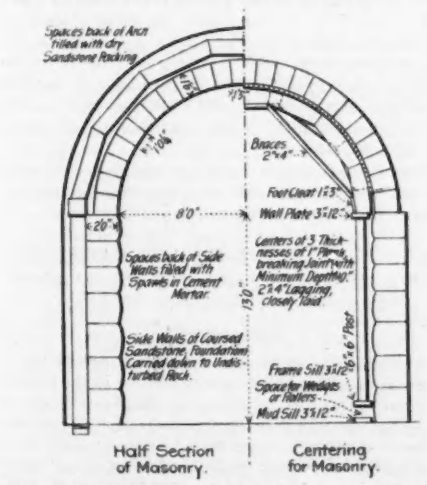


Fig. 3. Half Sections of Masonry and of Centering for Placing Masonry.

plate to admit of its being easily placed. The new wall-plate being in position, the excavation necessary for each of its imposed arches was made separately, each being erected, blocked and partially packed before the excavation for the succeeding one was commenced. The last arch being up, the heading was again driven forward for a new wall-plate. Side drifting to place the wall-plates, on which the arches were then built as in the method just described, was tried, but was almost immediately abandoned as more costly than that method. Owing to the great care thus taken by the contractors in all doubtful places, neither fatality nor accidental interruption occurred during the progress of the work.

The system of timbering is shown in Fig. 2. All timber was of white oak, and was carefully inspected; all sticks had to be in a thoroughly sound condition, and arch segments were rejected if they showed any sign of longitudinal cracking or splitting. The system of erection was as follows:

The heading being ready, a pair of wall-plates were brought in, and the engineers were sent for, to superintend the placing of them. This operation is described further on. The wall-plates were 12×14 ins. and 16 ft. long, and as the theoretical springing of the arch was at the lower side of the wall-plate, radial beds were adzed on its upper side, to make bearings for the arch timbers; the wall-plates were jointed by halving for a foot at each end, and were made in pairs, right and left, so that the forward end when in position might always show the lower section of the half joint, that being a material advantage in the placing of the plates. The wall-plates being in position and securely blocked against outward and downward movement, the joints were secured by tightening up the clamps. The detail of these clamps is shown in the elevation, Fig. 2. Stiffening planks 2×14 ins. and 2 ft. long were placed above and below the jointed plates, and drawn against them by tightening up bolts working through pairs of transverse straps. These bolts and straps are entirely outside the timber, and comprise all the permanent iron in the tunnel.

The arches were erected on the segment centers shown in Fig. 3. The arches are of 12×12-in. timbers, in seven segments, the segments being cut to template, and were erected by simply laying each segment in place on the centers. The centers were erected by jointing the two segments by the bolts shown in Fig. 3, and then blocking up their feet to proper position; the long hook shown was driven into the preceding arch, and served to hold the frame in position at its proper spacing; the second system of segment joint there shown proved the better in practice, being more readily handled. The arch segments being up, they were blocked solidly from the roof against all upward and outward movement, and 4×12-in. joggle-blocks with 8-in. shoulders were placed between consecutive arches at each joint. The centers were then withdrawn and the lagging commenced. The lagging was close-laid in lengths equal to the arch spacing and the bottom piece bore on the projecting back of the wall-plate. All voids back of the lagging were filled with broken sandstone brought into the tunnel for the purpose, and hand-laid. The use of sandstone was insisted upon because it was feared that the shale would deteriorate in time and yield under pressure if used as packing, thus giving the masses above a chance to start moving. The lagging and packing were carried up simultaneously, the packing of the crown segment being completed from between the next arches; and the timbering was completed by nailing up the two lines of 1×6-in. lacing plank at each joint. These lacing planks were to protect the corners of the segments from blasts, and were torn down after the tunnel was completed. They had the demerit of hiding the condition of the joint, and were accordingly omitted in bad ground.

As the bench was removed, the wall-plates were caught up on the plumb posts, due watch being kept that no length of the wall-plates was at any time left without ample support. The posts were underlaid by 4×12-in. plank in 6 ft. lengths, and wedges bearing upon these planks were driven until the post took a full bearing against the wall-plate above. The posts were spaced by 2×12-in. plank at foot and head. The lagging and packing were carried up simultaneously from the floor level, but it was not considered necessary to keep this work right up as in the case of the arch lagging, and it often fell considerably behind, the shale on such occasions proving itself amply strong to stand without support during the short period of exposure, the rate of disintegration being very slow in the unchanging atmosphere of the tunnel. No provision was made in this system for side-long pressure, and no need of such provision was developed.

By reason of the general plan of construction necessarily adopted, the company had to excavate a large and expensive section, but this section was reduced wherever practicable, and thus the clearance between the systems of lining was reduced to a minimum, necessitating very careful placing of the timbering. The wall-plates were the determining members of the timber system, and they were, therefore, placed by the engineering staff. The plan of operations was as follows:

Taking advantage of the fact that the main tangent in the tunnel passed out of the portal at the curved end well within the section, this line was established by five hubs, one over each portal, to serve as backsights, one on the summit and one well away from each portal, in such position as to command a full view of it. These latter served as instrument stations, and from them the line could be run right into the heading when necessary. No permanent points were established in the tunnel, the line being always brought up from the outside points when required; the P. T. was established temporarily and the curve run in from the tunnel tangent. The signal used in the tunnel was a small miner's lamp with a plumb bob hung below the center of the flame. When the tunnel was smoky, recourse was had to the gasoline lamps used to light the tunnel. These were known as "electric torches," and had a long pendant arm of gas pipe terminating in a bend and a small circular nest of burners, the plumb bob being attached to the center of this nest. On very bad days for seeing, the speediest method was to establish points on the tangents as far as could be readily seen, and then to move the instrument up into the heading and get it into range with the points. When needed, the line was marked by a temporary point opposite the forward ends of the new wall-plates, the position of the last wall-plate being always tried as a check. The level was then set up in the heading, bench marks being established in the tunnel, and the wall-plate was alternately shifted in grade and alinement until both were satisfactory. A miner's lamp, held close to the face of the rod, proved sufficient to illuminate both it and the cross-hairs of the instrument. The wall-plates

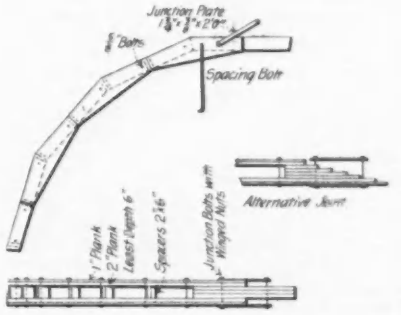


Fig. 4. Centering for Timber Arches.

were normally set ½ in. narrow, ½ in. high, and canted slightly inwards, these allowances being made to provide for the unavoidable settling under compression. When the heading was holed, the line and levels met within ¼-in.

The prices and cost were as follows:

11,726 cu. yds. excavation at	$2.85	.....	$33,419
742 " " packing	1.75	.....	1,298
256 " " fallen material	1.25	.....	320
303,000 ft. B. M. timber	30.00	.....	9,090
Total, 624 lin. ft. of tunnel		.....	$44,127

These figures were the contract prices, the actual cost being probably in the neighborhood of $35,000. In the approaches the prices were: Solid rock, 80 cts. per cu. yd.; loose rock, 40 cts., and earth, 20 cts. White oak timber was delivered on the ground for $15 per M., and cost $3 for framing. Common labor was worth $1.45 a day in the tunnel, and the miners were paid $1.75.

On considering the permanent stability of the tunnel, it was thought that if any ground movement should occur such as would bring heavy pressure upon the lining, it would be in the vicinity of the portals, while the timbering would decay most rapidly at the same place. It was therefore determined to put in portals and to build the masonry lining for 50 ft. at each end, as shown in Fig. 4. It was built of red sandstone, very coarse in structure and well adapted to resist the action of heated gases. The sidewalls were laid in courses, all stones being 2 ft. or more thick, and the bottom courses were extended into the tunnel, so that the ends of the courses might be racked off continuously from base to keystone, and the wall thus left in good condition for bonding on the resumption of work on the lining. The spaces between the plumb posts were filled with spawls in mortar. These walls were built with a small derrick set up without stiff-legs or guys, the pin at the top of the post being placed in an auger hole bored in the crown segment of one of the arches; and although the segment was not fastened in any way, the joint and lagging friction proved sufficient to overcome any stresses from the derrick tending to move the seg-

ment. The centers rested on a 3×12-in. wall-plate supported by rough 6×6-in. posts bearing on a 3×12-in. frame sill. The frame sill was carried by wedges working against a 3×12-in. mud-sill; the range of these wedges was large, so that the centers would be considerably lowered when the wedges were struck, and the whole section of centering might then be run ahead on small rollers placed on the mud-sill. With that purpose in view the posts were set far enough away from the side walls to clear the quarry face projections of the stones, and the first few pieces of lagging were omitted on each side of the center. The section of centering used was about 25 ft. long, the centers being spaced 3 ft. c. to c.; they were built of three thicknesses of 1-in. plank breaking joint, and with a minimum depth at joint of 10 ins.; the lagging was 2×4 ins. laid on the flat; the consecutive posts were fastened together by irregular diagonal bracing. The masonry arch was 18 ins. deep, the voussoirs measuring 1 ft. ¾-in. on the intrados and the keystone 1 ft. 3 ins.; all joints were ¼-in., and the voids between the masonry and the timbering were packed with dry sandstone, hand-laid. By reason of the impracticability of the ordinary methods of handling stone in the confined space between the lagging of the centers and the timbering of the tunnel, special methods had to be resorted to. The method employed was to leave an opening in the crown lagging of ample size to pass any of the arch stones. Above this opening a piece or two of the tunnel lagging was removed, and an iron bar placed upon the timber arches. A set of blocks was attached to this bar, and with their aid the arch stones were run up till they passed through the lagging, when they were swung off on to it. The difficulty was to get headway enough for the blocks to work in. Gas pipe rollers were placed under the stone, and it was run along on its side until it came opposite its destination. It was then canted upright, there being room to cant the stones at the joints of the timber arch only, and a single rope was passed round it. Six men were needed to bring it to place, two holding back on the rope from the opposite side of the centering, two aiding the slipping of the stone and guarding its edges from spawling, and two masons being below to receive it, throw off the rope and set the stone accurately, it requiring decided skill to bring the stone to its right place with an even mortar bed under it. The keystone was run into place dry and grouted. The head-wall of the portal was a rectangular block of masonry 25 ft. × 26 ft. × 4 ft. It was laid as first-class work, and the bond with arch was made by creepers. It was held that it was necessary to support these head-walls by buttresses, it being known that unsupported head-walls in tunnels in the same section of the state had failed under a gradually increasing movement of the material on the portal slope, this movement sometimes only commencing years after the completion of the work. The buttresses built were 8 ft. × 3 ft. in plan, and were stepped back towards the head-walls commencing at the springing level.

The prices on this work were $9 per cu. yd. for portal masonry, $8 for side-walls and $14 for arch sheeting. This cost was not included in the tunnel estimate before given, as the work was only partially done, and because the detail of the lining would probably be altered by the employment of a cheaper material when transportation facilities were obtained. The cost of one portal complete was:

76.5 cu. yds. portal masonry at	$9	$688.50
6.1 " " arch masonry "	14	85.40
		$773.90

and the cost per lin. ft. of lining was:

Side walls	2.57 cu. yds at	$8.00	$20.56
Arch	1.53 " " "	14.00	21.42
Packing	1.19 " " "	1.75	2.08
Lining per lin. ft			$44.06

In the estimate before given the cost of excavation, timbering, etc., was $44,127.60 for 624 ft., so that the total cost per lin. ft. of completed tunnel would be (excluding portals, fallen material, etc.):

Excavation	$53.55
Packing	2.08
Timbering	14.57
Side walls	20.56
Arch	21.42
Packing	2.08
	$114.26

Mr. Jos. N. Allston was resident engineer in charge, and the management of the construction was in the hands of Mr. John E. Dougher, of T. J. Steers & Co., who devised most of the practical points in the system above described.

Col. W. Haywood, for nearly 50 years engineer to the London City Commissioners of Sewers, has been relieved from continuous attendance at his office and made consulting engineer with his present salary of $12,500 continued in full.

WIRE GLASS.

The advantages of wire glass, or glass in which a sheet of wire netting is embedded, were pointed out in our issue of Dec. 21, and the advantages in point of strength, cohesion and consequent absence of the liability of broken pieces are especially apparent for such cases as windows and skylights of trainsheds and factories, pavement lights, etc. From the report of a committee of the Franklin Institute, recommending the award of the John Scott premium and medal to Frank Shuman for his machine and process of producing wire glass, we take the following particulars. The first invention of the kind was that of Newton, England, 1855, and other patents were granted as follows: Hyatt, England, 1871; Lake, England (for Beconlet and Bellet, France), 1876; Armstrong, England, 1887; Arbogast, United States, 1879; Thompson, United States, 1887; Tenner, Germany, 1888; Sievert, Germany, 1891; Shuman, United States, 1892. The latter were the only patents granted in this country for embedding wire netting in glass.

In the Shuman machine the table upon which the glass is rolled may be heated from below by large gas jets, prior to beginning work. The table is made preferably of cast iron, and is provided on each side with ribs of sufficient height to allow for the rolling of the glass, and on the outer edges are rails upon which the rolls travel. The carriage is provided with a front smoothing roll, a ribbed roll, and two following smoothing rolls, and is moved across the table by power transmitted by means of a sprocket wheel and link belt. The front roll smooths out the molten glass after it is poured upon the table and prepares it for the reception of the wire netting, which is fed down an inclined chute. The sheet of netting is preferably heated to the proper degree, so that it will not chill the glass. Directly back of the chute is a roll independently mounted in the carriage and having on its periphery a series of annular ribs to press the wire netting into the molten glass. The ribs may, if desired, be so arranged that, although all the wire is incorporated in the molten glass, some portions thereof will be pressed more deeply than others, thus corrugating the wire within the glass. A smoothing roll directly behind the ribbed roll then passes over the glass and closes up the openings made by the ribbed roll and wire, completing the rolling of the glass. A second smoothing roll is employed to correct the tendency of the rolled sheet, while still in the plastic state, to curl up over the first rear smoothing roll.

The finished glass is then removed and placed in an annealing furnace, and after it has been annealed any glass or wire projecting over the edges of the sheet is cut off, and the glass is then ready for the market. The smoothing rolls are made hollow, and the heads are perforated to admit a gas pipe with jets for heating the rolls before beginning work, so that they will not chill the glass during the process of rolling. The wire embedded in the glass not only strengthens the sheet, but also prevents the particles of glass from breaking entirely away from the main sheet, while, on the other hand, the glass protects the wire against corrosion, as has already been noted.

The pressure of the rolls in the later machines is about 50 lbs. per sq. in. The distance c. to c. of the ribs or grooves in the ribbed roll is 1 in. It has been found that with grooves of this size, any wire mesh between ¼ in. and 3 ins. can readily be embedded. These sizes of mesh represent the extremes of the sizes employed. A smaller mesh would require a groove of different size. The average temperature of the fused glass is about 3,000° F., and it is stated that the glass may be rolled at about 2,200° F., although the higher temperature is evidently the better one.

The inventions of Mr. Shuman are in practical operation on an extensive scale at the works of the American Wire Glass Mfg. Co., at Tacony, Philadelphia, Pa. The works cover an area of 1½ acres, and the plant at present consists of one main building, 300×100 ft., and two auxiliary buildings, each 20×150 ft. The glass melting plant is an eight-pot Siemens regenerative furnace of the latest design and capable of melting ten tons of glass per day. The fuel used is gaseous, furnished by three Wellman gas producers. There are twelve annealing ovens of the Belgian type for tempering the glass sheets immediately after the wire has been inserted, and to these the glass is carried in a tray. These annealing ovens are heated by the Aerated Fuel Co.'s system, using crude petroleum. The steam plant consists of one 50-HP. Babcock & Wilcox boiler and one 50-HP. upright boiler. All mixing and handling of glass is done by machinery. There are three sizes of rolling machines at present installed; two capable of rolling sheets up to 24×84 ins.; two capable of rolling up to 30×84 ins., and one machine capable of producing sheets as large as 54×144 ins. Machinery has been introduced for handling the product wherever it could advantageously be applied. All the waste material is removed by tramways, and all cars and wagons are loaded from overhead tracks. The waste ends and imperfect sheets are utilized by separating the glass from the wire by means of special bending rolls. The glass broken off is returned to the furnace and the wire, wherever practicable, utilized for other sheets. With the experience now gained in the operation of the plant, it is stated that the percentage of defective sheets made is so small that it does not enter as a factor in the cost of production.

The rapidity with which sheets are made varies with the thickness. With 3-16-in., the time of rolling is 18 seconds; with ¼-in., 25 seconds; with ⅜-in. and over, 35 seconds. The capacity of the plant is 5,000 sq. ft. per day of all sizes, and it is stated that the demand for the product has been large enough to keep the works fully occupied.

With its present facilities, which, it has been stated, will be extended as the requirements of business demand, the company is now engaged in the manufacture of wire glass sheets of any required dimensions up to 4×10 ft. and from 3-16 to 1 in. in thickness. It is manifest that there must be a limit beyond which it would not be prudent to increase the dimensions of sheets on account of their weight and the risk of cracking in handling and transportation. The usual dimensions for skylight and roofing glass range from 10×20 to 30×84 ins. Sheets larger than 48×144 ins., therefore, will rarely be called for. The objection that has been urged against the process because of the difficulty of cutting the sheets to desired dimensions is a real one, but to a great extent has been overcome. In the operation of cutting, the sheets are first scratched with the diamond, then broken across the cut, when the ductility of the embedded wire readily permits, by bending slightly to and fro, a sufficient separation of the edges of the cut to allow a thin-bladed saw to be inserted, by which the wires are cut through with comparative ease. In nearly all cases, however, the demands of the trade are for standard sizes, which require no cutting beyond that necessary to trim the edges.

The preliminary preparation of the wire for the production of the higher grades of wired glass consists in first removing the oil or grease from the wire by treatment with a cheap solvent (such as benzine), then passing the wire under a swiftly revolving roll, provided with bristles, and finally beneath flannel buffing wheels, whereby the wire is thoroughly cleansed and polished. For the best grades of wire glass, a specially annealed steel wire is used, which, after the cleansing treatment, presents a white and brilliant surface.

STAND-PIPE ACCIDENTS AND FAILURES.*

By Wm. D. Pence, Assistant Professor of Civil Engineering, University of Illinois.

Introductory.

In view of the extensive use within recent years of the elevated tank, commonly known as the stand-pipe, in connection with water supplies, there is no reason for surprise in the fact that a number of such structures have failed entirely and that others have sustained more or less damage from various causes. The records of this class of accidents heretofore published have been very incomplete either as to the number of cases described or in the extent and nature of the information given.

*Copyright, 1894, by Engineering News Publishing Co.

The record which is here presented is the result of an extended investigation of the subject and it is believed to be more complete than any heretofore compiled. While it is quite possible that a few instances of slight damage may not be included in the list, an extended search indicates that no accident of importance has been omitted.

At first thought, it may appear improper to include in such a record instances in which the resulting damage was relatively very slight, but the inclusion of several such cases seems fully warranted by the fact that a careful consideration of them serves to throw much light upon the causes and conditions which have led to other and more serious accidents.

Such a record should include a statement, not only of the conditions existing at the time of the accident, but also of the principal details of the structure itself. In attempting to comply with these requirements photographic views have been secured in a number of cases, of which several half-tone reproductions will be presented.

The investigation would also lack a very essential feature if the question of cause of accident were not especially considered. To this end comments of a more or less critical nature have been made and, in order to avoid the embarrassment which might result from such freedom, personal references of a damaging nature have been studiously omitted.

The term "stand-pipe," which is ordinarily restricted to relatively tall structures, is here used in the broader sense to include all of the forms of water-works tanks coming within the range of this record.

While the several descriptions are, in themselves, of interest historically, it should be observed that the most valuable and instructive points in connection with the subject are developed in the classification. The latter is believed to be the most extensive and, perhaps, the only one of the kind yet made. The classification above mentioned comprises a summary of the more striking facts developed in the detailed description and is accompanied by a brief discussion. Although the facts have, to a great extent, been compiled through reference to the files of technical periodicals, many of the more important points have been communicated to the writer and have not heretofore been published. Much of importance has been obtained only through persistent research and, in several instances, obscure sources of information have been reached by chance. The list of special references accompanying each description includes all sources from which facts have been drawn. The writer desires to here acknowledge the uniform courtesy and attention which his inquiries have received.

Cleveland, O., 1868.

The earliest stand-pipe failure of which a record is available occurred at Cleveland, O., early in 1868. The only mention of this accident to be found is the following brief account given by J. D. Crehore:

> Sometime in the spring of 1868, in Cleveland, O., a new wrought iron tank 60 ft. in diameter and filled with water to the height of 18 ft., burst and fell asunder. The thickness of the single-riveted sheets composing this tank did not exceed 3-16 in.

Diligent inquiry has failed to develop anything definite except that the tank in question did not belong to the water-works system of the city of Cleveland. A suggestion that it was a new oil tank being tested by water pressure seems plausible, but no facts either confirming or disproving this supposition could be secured.

Under the conditions above stated the unit stress upon the 3-16-in. plate, assuming 50% efficiency in the single riveted joints, would have been about 30,000 lbs. per sq. in. This fact in itself fully explains the accident, although other conditions, such as defects in individual plates, may have had some bearing in hastening the destruction of the tank.

References.—Van Nostrands' "Engineering Magazine," Vol. XXV., p. 330 (October, 1881). Correspondence with the Water Department and with the Standard Oil Co. (1893). Correspondence with W. W. Crehore, C. E. (1893).

Jersey City, N. J., Dec. 31, 1869.

On Dec. 31, 1869, the stand-pipe at Jersey City, N. J., collapsed and fell. It had been constructed in 1859 of plate iron ½ to 7-16 in. thick, and consisted of two parts, the lower portion being 160 ft. in height and having a diameter of 6 ft. at the bottom and of 4 ft. at its top. Resting upon, and braced to, the lower section by angle irons was a small cylindrical tank 10×10 ft., making the entire height 170 ft. It is said to have been riveted together in a horizontal position and afterward hoisted into place, which fact, it will be seen, probably weakened the structure.

The following statement by the engineer in charge of the pumping engine at the time of the accident has been secured through the courtesy of Mr. W. W. Ruggles, Chief Engineer of the Jersey City Water Department:

> The weather for a week previous to its fall had been about zero in the warmest part of the day, and for three days before its fall the temperature ranged from 2 to 10° below. The stand-pipe was nearly choked with ice. The engineer turned a steam pipe 2 ins. in diameter into the stand-pipe just above the discharge pipe, and tried in that manner to dislodge the ice. It relieved it partially and would probably have remedied the matter entirely, but for what followed. The tank, 10 ft. in diameter, which rested on top of the pipe, 4 ft. in diameter, was loaded with ice 3½ ft. thick. The ice in the stand-pipe was from 2 to 3 ins. thick, and the weather bitter cold. The wind, which had been in the northwest, suddenly turned to the southwest, and grew very warm. The sun and the wind together melted the ice on the south side of the pipe somewhat, and it toppled and fell. The pipe buckled at the point where, at the time it was hoisted into position, the lashings had been put about it.

In falling, the stand-pipe broke into three pieces. A statement which has been made to the effect that it was "repaired and re-erected," is incorrect; for a new stand-pipe, having a height of 160 ft. and diameters of 6 ft. 6 ins. and 4 ft. at base and top, respectively, was built on the site of the former one. In 1872, a brown-stone and brick tower, 210 ft. high, was built, inclosing with the above stand-pipe, a second one erected in 1871. The latter, situated 15 ft. from the other stand-pipe, is also 160 ft. high, but it has a uniform diameter of 6 ft. Both of them received a coating of silicious composition to prevent oxidation.

References.—Engineering News, Vol. VIII., p. 226 (June 4, 1881). "Proceedings of American Water-Works Association," 1888, p. 106. "Engineering and Building Record," Vol. XVII., p. 337 (May 12, 1888). Engineering News, Vol. XX., p. 272 (Oct. 6, 1888). "Manual of American Water-Works," 1889-'90, p. 203. Correspondence with Chief Engineer, Jersey City Water Department (1893).

Sandusky, O., Oct. 20, 1878.

This stand-pipe, built in 1876-7, is of steel and consists of two concentric shells, the outer, 25×180 ft., and the inner high-pressure pipe, 3×229 ft. The thickness of the outer shell ranges from ⅞ to 3-16 in., the bottom course being leaded into a segmental cast iron shoe which is set in a groove cut into the rock. The anchorage consists of twelve 1½-in. iron rods riveted to the second course of plates and wedged and leaded 3 ft. deep into bed-rock.

The high-pressure pipe originally had a thickness of ¼ in. for the first 100 ft., 3-16 in. for the second 100 ft. and ⅛ in. for the remaining 29 ft. An accident which occurred to this inner stand-pipe is thus described in the Annual Report of the Sandusky Water Department for 1878:

> During a fire on the afternoon of the 20th of October, the fire pressure-pipe burst at a point 50 ft. below top of large tank. The reaction caused by the water escaping through the rupture buckled over the pipe and forced it against the side of the large tank with great violence, breaking it in a second place, bruising and otherwise injuring a section of about 25 ft.

In repairing the damage caused by this accident, it was considered best to use ¼-in. plate, which required the removal of the section of 3-16-in. plate below the point of rupture. According to the above authority, "as the pipe stands the shell has a thickness of ¼ in. for the first 140 ft., 3-16 in. for 60 ft. and ⅛ in. for the remaining 29 ft."

It is a noteworthy fact that the Sandusky stand-pipe was a pioneer structure of its class, not only in the boldness of the design, but also in the character of the requirements for plate-metal. In reference to the latter, Mr. J. D. Cook, the engineer of the structure, says:

> The plates and rivet rods were manufactured with the greatest care and uniform fidelity by the Otis Iron & Steel Co., of Cleveland, O., and possessed a tensile strength (as shown by numerous and careful tests), ranging from 67,000 to 85,000 lbs., with elastic limit of 30,000 to 45,000 lbs. per sq. in. of sectional area.

No reference is above made to reduction of area or to elongation in the test specimens, but the range in tensile strength about corresponds to the grade of structural steel now designated "high steel." Although the ductile properties of the latter grade of steel are now regarded as too low in the better practice of tank construction, the use of that or its equivalent grade at the date referred to was undoubtedly a step in advance. Under the strict system of inspection during construction it is improbable that seriously defective material or workmanship of any kind was admitted, and since the nominal working stress in the 3-16-in. plate in which the initial rupture took place was well within the limit of safety, it would seem that the accident was due to some influence brought to bear after completion of the stand-pipe.

The latter seems to have been the case, for it is credibly stated that previous to the accident of Oct. 20, 1878, above described, the inner pipe was inadvertently permitted to be empty while the annular space between the two shells was full of water (a condition against which the designer had expressly advised); this "caused its first collapse, buckling against the walls of the large pipe at opposite sides."

The accident last above described was evidently the more critical of the two, for it not only exposed the greatest inherent weakness of the inner stand-pipe, but also probably developed the flaw to which the later failure was due. The contrast in the existing conditions in the two cases warrants double mention in the classification. The exact date of the earlier accident was not available. It should be observed that the main outer shell sustained no damage in either case.

References.—Sandusky Water Department Report, 1878. Tenth Census, Vol. XVII., Water Supply of Cities, p. 61. Engineering News, Vol. XVI., p. 316 (Nov. 13, 1886). Sanitary Engineer, Vol. XV., pp. 259-260 (Feb. 12, 1887). Manual of American Water-Works, 1889-'90, p. 381. Correspondence with the designing and consulting Engineer (1893).

(To be continued.)

TESTS OF A STIRLING BOILER.

Some evaporative and capacity tests were recently made by Mr. Geo. H. Barrus, M. Am. Soc. M. E., on a 250-HP. Stirling boiler in the power house of the Portland (Me.) Electric R. R. Co. The boiler has a grate surface of 57 sq. ft. and a water-heating surface of 2,552 sq. ft. The system of firing followed was to supply coal in small quantities upon the front of the grate to a depth of 4 to 6 ins. Once in about three firings the incandescent coal on the front of the grate was pushed back to cover the rear end. The two tests for economy were made, as will be seen, with a very light draft and a moderate rate of combustion. The detailed figures are as follows:

	Date, 1894. Jan. 21.	Jan. 23.
Total quantities:		
Duration ..... hrs.	7.52	8.57
Dry coal consumed inc. wood equivalent ..... lbs.	4,397.	5,713.
Ashes and clinkers..... "	240.	490.
Combustible consumed.... "	4,067.	5,223.
P. c. of ashes and clinkers. %	5.6	8.6
Water evaporated ..... lbs.	45,411.	60,217.
Hourly quantities:		
Coal consumed..... lbs.	572.7	666.6
Coal per sq. ft. of grate... "	10.04	11.69
Water evaporated..... "	6,038.7	7,026.5
Equiv. evap. from feed at 100° to 70 lbs. pressure.....	5,489.2	6,401.1
HP. developed on basis of 30 lbs., from 100° to 70 lbs..... .....HP.	183.0	213.4
Equiv. evap. per sq. ft. heating surface ..... lbs.	2.15	2.51
Averages of observations:		
Boiler pressure..... lbs.	113.	123.3
Temp. of feed water.....deg.	210.	210.
Temp. of flue gases..... "	437.	478.
Draft suction..... ins.	0.07	0.11
P. c. moisture in steam.....%	—	0.06
Results:		
Water evaporated per lb. of coal ..... lbs.	10.544	10.54
Equiv. evap. per lb. of coal from and at 212°.....lbs.	11.018	11.025
Equiv. evap. per lb. of combustible from and at 212° lbs.	11.672	12.061

Two capacity tests of this boiler were also made which are notable on account of the small percentage of moisture in the steam. The figures are as follows:

Date, 1893. Draft area.	Dec. 14. Full.	Dec. 19. Reduced.
Duration ..... hrs.	2.0	2.0
Water evaporated	24,907.	23,590
Water evaporated per hr.. "	12,498.5	11,795.
Equiv. evaporation per hour from feed at 100° to 70 lbs. pressure	11,398.6	10,733.4
HP. developed on basis of 30 lbs. from 100° to 70 lbs HP.	380.	357.8
P. c. in excess of rated capacity ..... %	52.	43.1
Equiv. evap. per sq. ft. heating surface pr. hr.....lbs.	4.46	4.2
Average boiler pressure.. "	128.7	128.
Ave. temp. of feed water.deg.	208.4	207.3
Ave. temp. flue gases...deg.	Above 600°	—
Average draft suction....ins.	0.44	0.44
P. c. moisture in steam....%	—	0.19

A FLYWHEEL PUMPING ENGINE FOR HEAVY PRESSURE.

(With inset.)

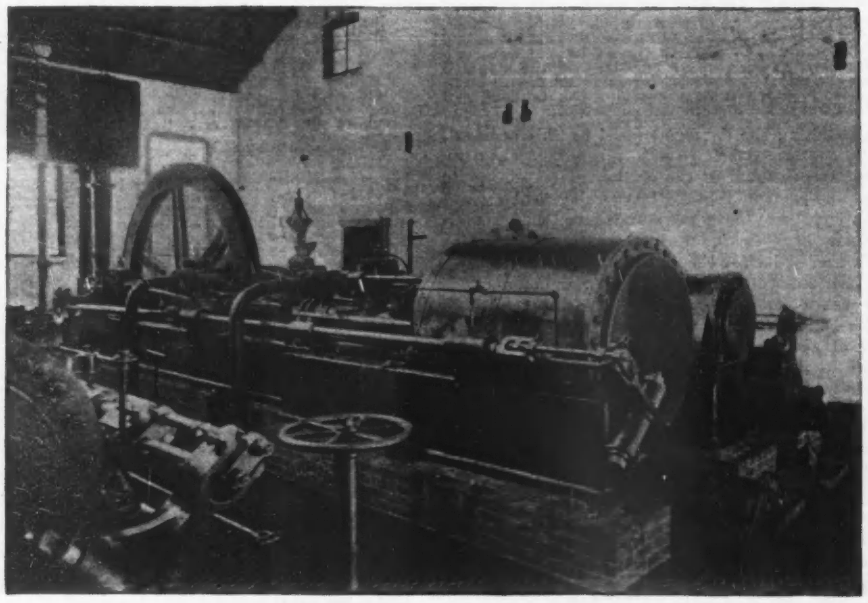
We illustrate on our inset sheet this week and show herewith a perspective view of a pressure pumping engine of unusual size and power, designed to work against a pressure of 3,000 lbs. per sq. in. and to deliver 125 gallons per minute, thus developing, when working at its full capacity, a total of 218 HP. The steam cylinders are compounded and are respectively 22 ins. and 42 ins. in diameter and have a stroke of 36 ins. They are designed to use steam at 125 lbs. pressure; and when delivering the amount of water above stated the flywheel runs at 40 revolutions per minute. The engines can be safely run, however, at 60 revolutions. The water is delivered to an accumulator, from which it is led to various hydraulic machines.

While the engine is designed for the pressure above stated, in every-day use 2,500 lbs. per sq. in. is the usual pressure maintained. The plant consists of two duplicate engines, each connected to a Wheeler surface condenser placed beneath the floor, and each engine drives its own air and circulating pumps.

The flywheel enables the steam to be cut off before the end of the stroke, and is claimed to effect a marked improvement in the fuel economy. The engines are, of course, so connected to the accumulator as to start and stop automatically. A governor is attached to each engine and regulates the speed, preventing the engines from starting too quickly in case of a sudden draft on the mains. Should a main burst, the governor flies up and stays there, so that the engine cannot run away. The friction loss in the engines is said to be only 5%.

These two engines were designed by Mr. Ernest W. Naylor, M. Am. Soc. M. E., for the United States Projectile Co., of Brooklyn, N. Y., and replace two pairs of tandem compound condensing pumps of the common direct-acting type. We are informed that the direct-acting pumps required a steam pressure of 125 lbs. and the boilers had to be forced to keep up the steam pressure. The new flywheel pumps give 100 to 125% more water at the same pressure and will work with 40 lbs. less boiler pressure. Mr. Wm. H. Law, the engineer of the United States Projectile Co., states that the old direct-acting pumps used on the average 15 tons of coal per day, while the Naylor engines when doing a corresponding amount of work consume only 6 tons per day.

The type of engines designed by Mr. Naylor are built by the General Mfg. Co., of Bound Brook, N. J., which company is now the sole builder of hydraulic machinery under Mr. Naylor's patents.



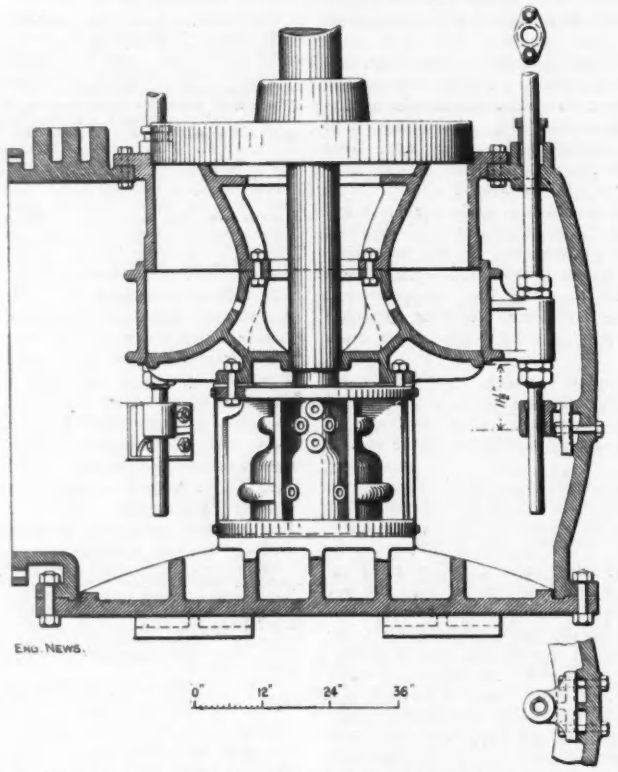
THE NAYLOR CROSS-COMPOUND FLY-WHEEL PUMPING ENGINE FOR HEAVY PRESSURE.

GEYELIN-JONVAL TURBINES IN PLANT OF THE NIAGARA FALLS PAPER CO.

By Emil Geyelin, Designing Engineer.

The firm of R. D. Wood & Co., of Philadelphia, started last month the Niagara Falls Paper Co.'s three turbines, which are the first hydraulic motors to discharge into the great Niagara tunnel. These turbines are each of 1,100 HP. and work under a head of 140 ft.

According to the contract under which they were built, the arrangement of the wheel pit, with the superstructure to hold the turbine shafts, was to be such as to permit the placing of additional turbines in the same pit. It was further stipulated that the power of the three turbines was to be transmitted to three horizontal shafts, each shaft to make 200 revolutions per minute when doing full duty.



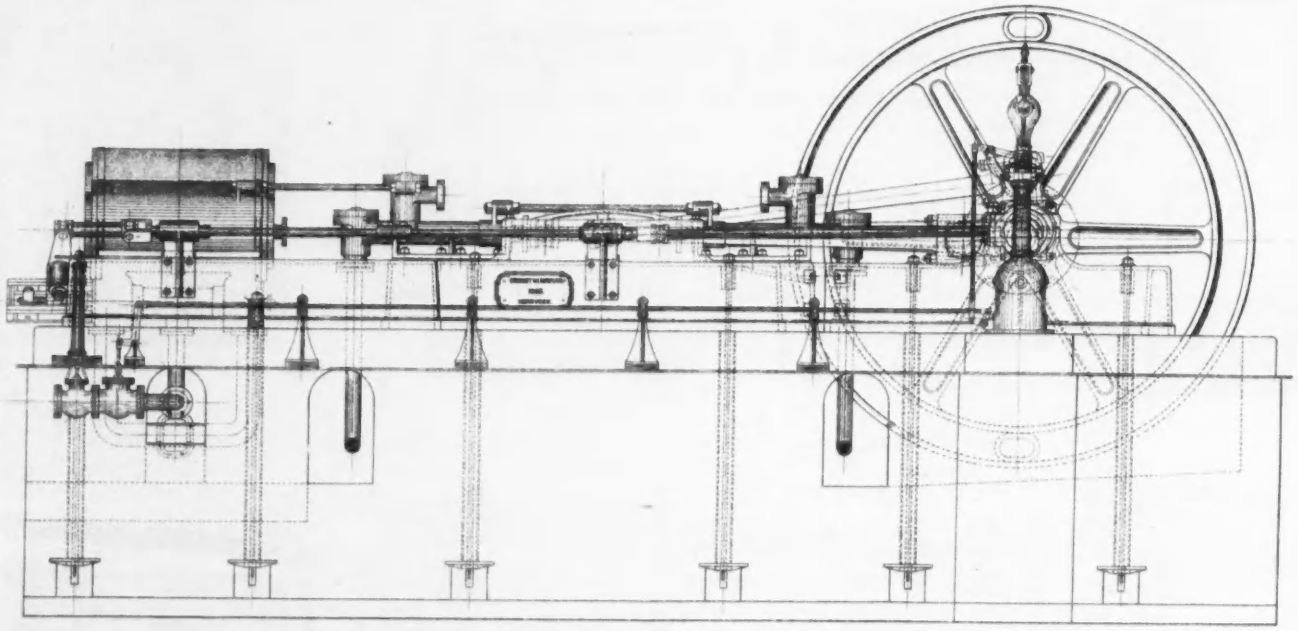
VERTICAL SECTION OF GEYELIN-JONVAL TURBINE OF 1,100 HP. FOR NIAGARA FALLS PAPER CO.

The first consideration was to group six turbines into as small a pit as possible so as to occupy minimum space, allowing only for the proper waterways in addition to the turbine casings and hydraulic gates; it being well understood that every square foot of pit thus saved not only reduced the cost of blasting the pit out of the solid rock for the whole depth of 156 ft., but it also reduced the length of the numerous girders and girder frames which became necessary to steady the bearings of the turbine shafts.

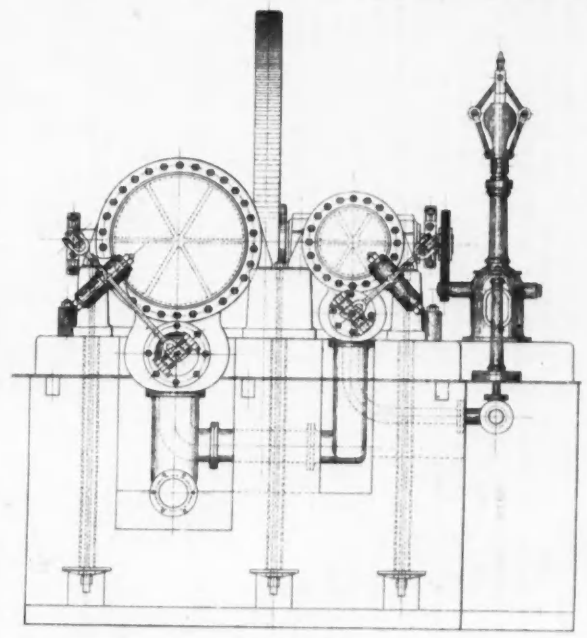
The engineer of the Niagara Falls Paper Co., Mr. A. B. Tower, required the three first turbines to transmit their power to the same side of the pit, and stipulated the distances apart of the horizontal shafts. Had it been otherwise, it would have been a comparative easy matter to have grouped the three wheels under contract around one penstock. The following is an outline of the methods employed in solving the problems presented in the design of the plant:

First, as to the penstock we had a given quantity of water to be brought in the most effective manner to the turbine casings. The penstock had to be designed to supply ultimately four turbines of 1,100 HP. each, so that a future penstock would be required to supply only two turbines.

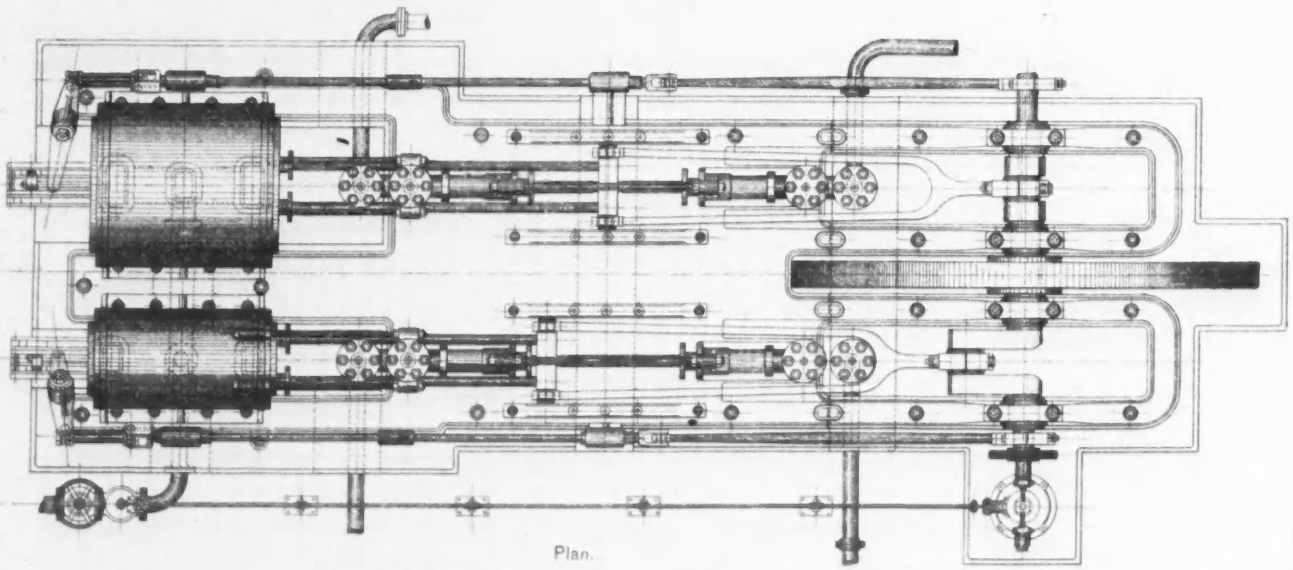
From the number of horse power and the height of fall, it was readily computed that with an efficiency of 80%, it would require 5,186 cu. ft. of water per minute for each turbine; in other words, this penstock had to be so proportioned as to bring 20,744 cu. ft. of water per minute to the turbines with the highest efficiency. Assuming a velocity for the water in the penstock of 145 ft. per minute gave a diameter of 13 ft. 6 ins. for the penstock. The turbines, according to the calculation, were required to be 4 ft. 6 ins. in diameter; but with the view of meeting what was judged to be the necessary diameter of the driving bevel wheel this diameter was increased to 4 ft. 8 ins. and thereby a speed of 200 revolutions was attained when the turbine is doing full duty. To allow sufficient waterways around the guide-wheel and hood as it approaches the turbine proper, the casing of the turbines was made 8 ft. in diameter. With these main dimensions it became possible to bring the distances between the center of the penstock and the centers of the turbine to 13 ft. 6 ins. as a minimum. This enabled us, by placing the four inlets at an angle of 45° to the main inlet, to make 28 ft. the



Side Elevation.



End Elevation.



Plan.

Cross-Compound Fly-Wheel Pumping Engine; Capacity 125 Gallons per Minute under 3,000 lbs. Pressure per sq. in.

Designed by Ernest W. Naylor, M. Am. Soc. M. E.,
for the United States Projectile Co., Brooklyn, N. Y.

CHAS. HART & SONS, LITH., 35 VESEY ST., N. Y.

minimum width of the wheel pit. The length of the pit was controlled by the required space between the three horizontal shafts (33 ft.), which brought the length to 43 ft.

At the bottom of the penstock, as provision had to be made to ultimately supply four turbines, it was necessary to provide four openings, each 66 ins. in diameter, or sufficient to admit, without throttling, the necessary quantity of water to each turbine. As these openings had, however, to be distributed on the whole periphery, it gave but two openings on each side, which served to supply turbines No. 1 and No. 2. To supply turbine No. 3, although the iron of the penstock was ⅞ in. thick, it was deemed unsafe to provide a fifth opening in the same plane. To meet the difficulty the fifth opening was provided, 13 ft. higher, which thence joined the truncated section of the future additional penstock 9 ft. in diameter, to which the third turbine is attached.

As to the turbines and their component parts, the great advantage was early seen of adopting the inverted plan, whereby the great weight of the shafts and gears would be to a large extent counterbalanced by the upward pressure. Two main features in the turbines required special attention: First, the movable and guide wheels had to be so planned as to give the proper speed and power necessary; second, the gates and gate motions had to be so designed as to be moved quickly up and down by the governors under the pressure of 60 lbs. per sq. in.

Regarding the proper speed of the turbines it should be said that this was in part controlled by the bevel wheels which transmit the power to the horizontal shaft. It was judged unsafe to make a smaller set of bevel wheels than those now in operation, and we were therefore forced to increase the diameter of the movable wheels slightly, which brought the speed of the turbines to 260 revolutions per minute. With the view of obtaining finer lines and a great durability of the movable wheels, the rims were made in bronze. They are 4 ft. 8 ins. in diameter and have 30 apertures.

For the gate and gate motions the Geyelin-Jonval patent gates have been adopted. These are provided with stout sleeves, each weighing 2,800 lbs., sliding outside the guide wheels to hoods. When closing these sleeves are guided by four rods which extend above the turbine casings some 10 ft., where they are united and attached in each case to a yoke which is suspended from a lever. To the end of this lever a wire rope is attached which extends to the mill floor above and, passing over a pulley drops down some 10 ft. To its end is attached a counterweight which largely counterbalances the weight of the gates and rods.

While the steps under the turbine shafts are designed to receive the weight of the turbine, shaft and gears above in case of an accident, yet they are in no way intended to carry any weight while the turbines are in operation. In connection with each step there is below the turbines an adjustable guide bearing lined with lignum-vitæ, which serves to guide the turbine shafts inside the casings.

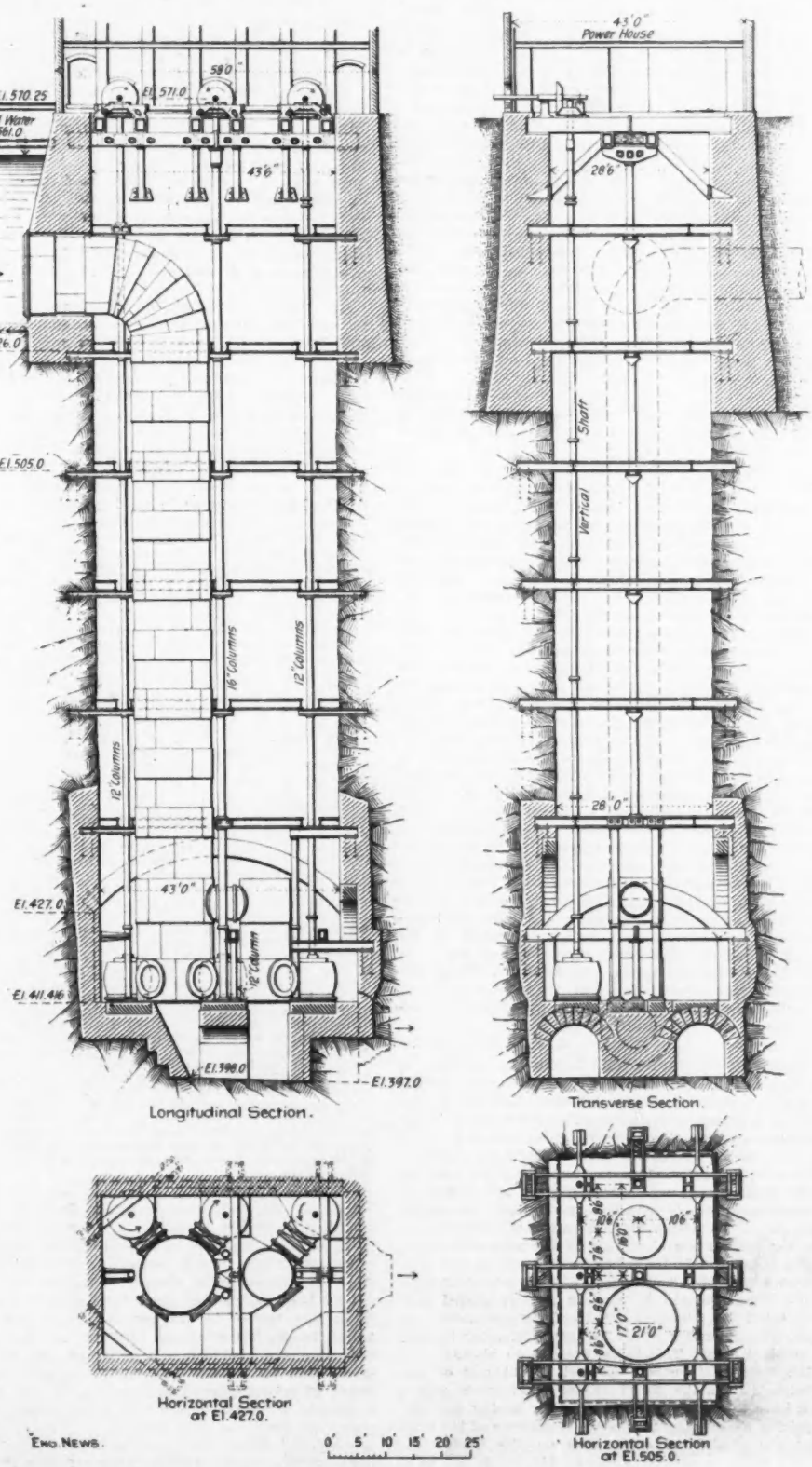
Coming now to the design of the superstructure to firmly hold the upright turbine shaft, special attention was given to the section close to the turbines and to the section close to the bevel pinions which deliver the power to the horizontal shafts. In each case we provided heavy cast iron girders; the bottom girder being 30 ins. deep and 18 ins. broad, supported in the center by two columns. For the upper part near the gears we have for each shaft a double framework, also in cast iron, giving support to two ample bearings.

In addition to the above provisions for steadying the shafts, each shaft is provided near the bevel gears at the top with a thrust bearing, intended to take any upward or downward pressure which occurs in the turbine while working with different gate openings. Thus when the turbine gates are half open, the pressure on this thrust bearing is downward, and when full open it is upward.

The most interesting feature connected with this work was the design of the gears to transmit the motion to the three line shafts. The speed of these shafts was required to be 200 revolutions per minute, and the amount of power to be transmitted and the bearing surface required brought the external circumferential speed of these wheels to 4,000 ft. per minute.

The more I studied the problem the more I became convinced that with the certainty of having to meet sudden violent changes amounting to 100 or 200 HP., nothing short of mortise wheels would answer. The very fact of having to meet these changes in power transmitted led us to employ comparatively soft material (wood) for the driven gears. This brought about a diameter of the wheels which could not safely be reduced, yet such a circumferential velocity has thus far, so far as I can learn, never been attained in gears transmitting large power; I could find no record of any speeds above 2,800 ft. per minute. Necessity forced me to adopt the unprecedented speed of 4,000 ft. per minute. The safety of these gears at such high speeds required that their shafts be firmly secured to prevent springing, and that the periphery of the mortise wheel should be strengthened. To secure the first requirement, a formidable system of interlocked cast iron girders spanning the wheel pit and firmly anchored into the masonry was erected. This framework, without including the pedestals (four to each pair of wheels), required 270,000 lbs. of metal. By the use of a ten-ton traveling crane this difficult work was all erected without accident to the men in charge.

Under the intelligent supervision of Mr. Walter Wood, M. Am. Soc. M. E., the engineers of the Camden works rendered me valuable assistance in proportioning this important work.



WATER-POWER PLANT OF THE NIAGARA FALLS PAPER CO.
R. D. Wood & Co., Philadelphia, Pa., Contractors; Emil Geyelin, Designing Engineer.

PERSONALS.

Mr. William Nelson has been elected City Engineer and Superintendent of Sewers at Laconia, N. H.

Mr. Michael Keegan, railway contractor, died March 26 at Louisville, Ky.

Mr. R. E. Newmeyer, Borough Engineer of Bethlehem, Pa., has been put in charge of the Bethlehem water-works in addition to his other duties.

Mr. George C. Baker, inventor of the Baker submarine torpedo boat, described in our issue of Sept. 21, 1893, died at Washington, D. C., March 23.

Mr. A. T. Dice, Superintendent of Signals of the New York Central R. R., has accepted the position of Division Superintendent of the Philadelphia & Reading R. R., with headquarters at Atlantic City, N. J.

Mr. Edward B. Wall, M. Am. Soc. M. E., Assistant to the First Vice President of the Pennsylvania lines west of Pittsburg, died on April 1, at a Pittsburg hospital from peritonitis and shock following an operation for appendicitis. Mr. Wall had been ill for several days, but had exhibited no dangerous symptoms until Saturday, March 30, when he began to fail alarmingly. On Sunday morning he was taken to the hospital, where the operation was performed, but apparently too late for successful results.

Mr. Wall was only 38 years old at the time of his death, but he was already one of the best known, as he was one of the most brilliant men in the railway service of the country, and he was unquestionably in the line of direct and rapid promotion to the highest positions in the gift of the great corporation to which his service has been confined since he entered it in 1876. He was born in Kingston, N. Y., April 25, 1856, and graduated from the Stevens Institute in 1876, in the fourth class, and the first large class (16) ever graduated from that institution. The ability displayed in his thesis, which was on the subject of car-framing, was the immediate agent in attracting the attention of the Pennsylvania officers to him, and led to his appointment on the staff of the Superintendent of Motive Power, under the enlightened policy of that road, which puts a certain number of such young men in training as possible material for managing officers. He was 20 years old when thus appointed. At 23 he was an inspector of materials and a car designer; at 26 an assistant master mechanic; a few months later assistant engineer of the motive power department, and at 27 he was appointed Superintendent of Motive Power of the Pennsylvania's Southwest system, probably the youngest age at which any man was ever appointed to so responsible a position in an old established company. This position he held with distinguished credit to himself and to his company for ten years, but in March, 1893, he was promoted to his present position.

Mr. Wall's greatest public service was in connection with the automatic coupler issue. He took an active part in the Master Car Builders' Association after its reorganization with representative members, and to him more than to any other one man was due the admirable work of that association in connection with the automatic coupler question and the advanced status of practice to-day. He was universally liked and respected, and his untimely death will be deeply regretted by all who knew him. He leaves a widow and one son.

SOCIETY PROCEEDINGS.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on March 17 102 members and visitors were present. Mr. J. S. Robinson dealt with the discussion on Professor Marburg's paper on "Designing of Plate Girders," presented at the last meeting (Engineering News, March 22), and stated that as a rule specifications here call for a metal too hard to give best results. In England and on the Continent, where structural steel is more universally used than in the United States, a softer steel is used than is ever put into similar work here; the ultimate strength not exceeding 60,000 lbs per sq. in., and averaging nearly 57,000 lbs. with an elongation of about 30% and a reduction of over 50%. One of the advantages of this softer steel is that it cannot be injured by careless or ignorant shop work, and it is even difficult to burn it. It is also more homogeneous and is much less liable to injury in the rolling mill. Mr. E. R. Kellar then spoke of some of the results obtained in the government investigations of American timbers carried out under the supervision of the U. S. Forestry Bureau. He described the apparatus and methods of testing used by Prof. J. B. Johnson, and spoke of the deductions from these tests as made by Professor Johnson. Mr. F. H. Lewis presented a paper on the new building law of Philadelphia, enacted in June, 1893. He pointed out what he considered serious defects in matter and arrangement. This paper was discusssed by a number of members present, and the general opinion seemed to be that the new law was too verbose, being made up of clippings from other laws loosely put together and conflicting and obscure in meaning. L. F. Rondinella, Secy.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on March 21, Mr. S. Bent Russell addressed the club on the leading engineering features connected with the water-works extension, together with the organization and methods of the engineering force. Particular attention was paid to the question of determining the design of inlet tower, intake tunnel, engine house and conduit, together with a description of the methods employed in construction and the difficulties encountered. The conduit is about 37,000 ft. long. From the Chain of Rocks to Baden it is 11 ft. diameter, and is expected to deliver 100,000,000 gallons per 24 hours. From Baden to Bissell's Point it is 9 ft. diameter, and has a capacity of 65,000,000 gallons. These calculations are based upon a computed velocity of 2 ft. per second. Wm. H. Bryan, Secy.

LIVERPOOL ENGINEERING SOCIETY.—At the meeting on March 14 a paper was read by Mr. C. R. Bellamy, Superintendent of the Gas Department, Liverpool Corporation, on the "Progress of the Science of Gas Combustion." After dealing with the magnitude of the gas industry in England, involving an annual coal consumption of 11,000,000 tons and producing an income of $92,500,000, he referred to the great waste of gas due to general ignorance of the simple laws governing gas combustion. Reference was made to the importance of adjusting the pressure of the gas to the requirements of the burner, and it was shown by experiment that the gas consumed by an ordinary burner might vary under the usual fluctuations of pressure in the gas company's mains between 4 and 10 cu. ft. per hour. The great economy was pointed out of using "governor" burners, in which the consumption is permanently adjusted to the requirements of the burner, insuring uniformity both of gas consumption and light. He dealt in detail with the merits of the various forms of all the gas burners at present in use, and proved by experiment that some burners were capable of yielding ten times as much light from a given quantity of gas as other burners of inferior type.

ENGINEERS' CLUB OF CINCINNATI.—At the March meeting Mr. C. Wood, Chief Engineer of the Cincinnati, Hamilton & Dayton R. R., read a paper on the construction of a new freight house recently built by his company at Cincinnati for outbound business. The principal building and an additional covering for a platform of brick paving are constructed of iron work, having posts of four angles latticed, resting in cast iron shoes filled with concrete. The purlins, trusses and all parts are of iron. The sides above the sash over the doors and the roof are covered with galvanized iron. The floor is of 3-in. oak on stringers bedded in cinders. Rolling steel shutters are used, made in two 10-ft. parts, in 20-ft. space, with the post between hung on a pivot to permit its being swung back, thus making an opening 20 ft. in the clear. The particular feature was the difficulty to be overcome from the peculiar situation, the shape of the lot being approximately triangular, and the grades of the streets fronting on two sides being such that their intersection at the corner of the building was some 15 ft. higher than the grade of the streets at the crossing of the railway. This necessitated a grade in the floor of the building from the street to the tracks, a grade in the building from one end to the other, a grade in the tracks adjoining the building and a change in the direction and width of the building, which required a separate plan for each panel and truss throughout the structure. These difficulties were all overcome in the design adopted. The building is 684 ft. in length and the entire arrangement gives a capacity of 106 cars.

J. F. Wilson, Secy.

CENTRAL RAILWAY CLUB.—At the meeting at Buffalo on March 28, Mr. Waitt (Lake Shore & Michigan Southern Ry.) and Mr. Mitchell (New York, Lake Erie & Western R. R.) referred to their use of brake instruction cars and schools, the Erie having a school at each division terminal shop. Mr. Higgins (Lehigh Valley R. R.) referred to the importance of devising some arrangement which will prevent the closing of stop-cocks by people who have no business to meddle with them. If this is done one cause of accidents occurring because the air-brakes do not work will cease.

Mr. Mitchell said there had been cases on the Erie where a stop-cock was undoubtedly closed by tramps.

Mr. West (Ontario & Western Ry.) suggested that this could be overcome by requiring enginemen to make an application of air at 1,000 yds. after leaving a terminal point. This is the practice on his road.

Mr. Bronner (Michigan Central R. R.) was of the opinion that as the use of air-brakes increases plants will have to be established for proper testing and the repairing of defects. It was the experience of his road that the closing of angle-cocks on the tender occurred most frequently, and for this reason all such angle cocks have been removed.

Mr. Chubb, referring to this last remark, said that the accidental or willful closing of angle-cocks occurred on the tanks of tenders, and every one of these cocks having been removed, no more trouble from this source was expected. Experience had shown that if angle cocks were found closed in the train line, it was due to the failure of the trainmen to open them. In Mr. Chubb's opinion the use of angle-cocks in passenger service was entirely unnecessary.

Mr. Petrie explained how the testing plant of the New York Central R. R. at East Buffalo is constructed and operated. It is not the custom to test each car separately, when 10 or 15 can be coupled together. Repairs of some kind have to be made to about 20% of cars equipped with the air-brake, and not one car in 1,000 has to be switched out for repairs.

Mr. Small (Buffalo, Rochester & Pittsburg R. R.) stated that a plant was maintained on that road similar to that of the New York Central and the results were the same.

Mr. Sutherland (Chicago & Grand Trunk Ry.) favored an instruction car, no man to be given a place until he is able to pass an examination.

Mr. Miller (New York, Chicago & St. Louis Ry.) reported that all enginemen, firemen, conductors, inspectors and brakemen had been required to go to school on the air-brake car. The result is that all are well educated, and the amount of air used has been reduced two-thirds. Rough handling of cars is of rare occurrence, and when it takes place the engineer is taken off and sent to school again.

Mr. Mitchell expressed the opinion that once a year was often enough to oil brake cylinders, with the average mileage of 20 miles a day that freight cars are making.

Mr. Chubb said this was the experience of the Michigan Central. He had found cylinders that were fairly well lubricated at the end of two years.

Mr. Petrie found little trouble with dry cylinders, but favored turning the piston half way around.

Mr. J. B. Morford, Superintendent of the Canada Southern Division of the Michigan Central R. R., then read a paper on the "Requirements of a Typical Yard at Large Interchange Points and the Characteristics of and Difficulties in Terminal Yards," in which he referred to the inadequate accommodation generally found and the slowness in making improvements.

A typical yard at an interchange point, in my opinion, should be a poling yard for the breaking up of trains, with ample track room sufficient to promptly handle all traffic that might be presented, whether it be more or less. With a poling yard one engine with a crew consisting of yard conductor and five helpers, and an engine, conductor and two helpers, nine employes all told, would do the switching that five or six engines are doing at the present day in the old style of yards. On the arrival of each train the switchman in charge of the poling engine receives from the car checker a list showing him for which road each car on each train belongs. The conductor then takes his switching list and marks each "cut" in this train, one of the helpers is placed at the switches, one couples as cars are poled and three do the riding. The car is marked with chalk on the end by the yard conductor, designating to the switch tender which track the next car that is poled is to go on, and so it goes until all the train is grouped. The feeding engine has another train ready to go through the same process. In this way a train of 40 cars is grouped for the various roads on an average of 15 minutes, 160 cars an hour, or 2,000 cars in 12 hours (a day's work) with a possible delay to the freight of 45 minutes from the time of arrival to the time of departure. No freight is allowed to pass other freight that has previously arrived unless by special request. These trains being made up from the poling yard into the receiving yard are immediately dispatched on to destination, and this saves complaint, long delay and expense in handling.

The difficulties in a terminal yard are the lack of proper carding of cars, prompt forwarding of the billing and not having sufficient track room to get trains into a division point quickly. The road doing a competitive business should have a few miles of double track to be able to dispatch its outgoing trains when made ready, and not be obliged to wait for an incoming train to arrive, bunching the traffic in many cases, with a long delay. Cars on arrival should at once be carded, using a different kind and colored card for each road, then cars are delivered to the interchange yard. Chalking of cars I find does not work well, as in severe storms the chalk rubs off and the yard masters have no carding to switch by. With colored cards yardmen soon become conversant with them and at a glance, and without any further trouble or instructions, know how to place them and where they belong.

WESTERN RAILWAY CLUB.—At the meeting on March 20, the committee on "The Best Method of Handling Defective Air-Brake Cars" presented its report, stating that the most satisfactory method of reporting defects which cannot be repaired at the time of discovery is by the use of a small card, filled out by the conductor or inspector discovering the defects, and applied to the car at once. This ticket would be an indication to yardmen or trainmen at once that the air-brake was defective, and in many cases what the defect was, and hence would be the result of saving quite a little in delayed time and in switching at terminal and junctional points, where trains are broken up and reassorted. A form of card was submitted and the report stated that it is very desirable that some uniform style of defective air-brake card be adopted, and that inasmuch as the subject seems to have had careful consideration by at

least one other railway club, it was suggested that the Master Car Builders' Association be requested to appoint a committee to recommend a form of card for general use by any or all roads.

The discussion of Mr. Quereau's paper on "Steam Distribution of High Speed Locomotives" (Engineering News, March 8) was then taken up, and Mr. Quereau read a communication from Mr. Vogt, of the Pennsylvania R. R., agreeing with Mr. Quereau's views relative to the desirability of increased valve travel, together with considerable outside lap and inside clearance in locomotives for high speed service. In compounds especially this holds true, as shown by cards from the P. R. R. compound engine before and after changes were made in the lap and inside clearance. The cards were taken to ascertain if possible the cause of soot from the smoke box being drawn into the low pressure cylinder, and emphasized the necessity of large relief valves, showing that those in use were not large enough, though each had an aperture of nearly 3 ins. This is a rather serious matter, which probably exists on other engines. The following is an abstract of a discussion sent in by Mr. D. L. Barnes:

I do not understand that "there is a growing conviction in Europe that the economical length of train has been reached, and there is therefore a movement towards increase of speed." In Europe, as in this country, not only are train weights increasing, but also the weights of locomotives. The increase is slower, however, in Europe, than here. The statement that "to increase the capacity for speed of any locomotive its power must be increased, and at least by as much as the speed is to be increased," is probably true for constant speed after the speed has reached 60 or 70 miles an hour, but it is not to be taken as true for a change from 30 to 60 miles an hour, as the rule will not apply to such a case.

The matter of the effect of lead and compression on the economy of an engine is by no means settled yet, as but little is known about it. The most economical point of compression is not up to the pressure of admission for locomotives, but at a point considerably below that. I do not understand from Mr. Quereau's paper that he wishes to say that the lead used in ordinary locomotive practice is uneconomical or disadvantageous, because it is a very difficult matter to prove, and I should feel inclined to question the proof of such a statement. One of the best features of the Stephens on link motion is the increase of lead which it gives at a short cut-off and high speed.

Mr. Gibbs.—One point Mr. Quereau touches upon, which seems to be especially important, is the effect of high speed upon the amount of steam required from the boiler. Large modern locomotives have been a disappointment to a great many motive power men, who say that they do not get proportionally as much work out of them as they used to get out of the small engines they have displaced, but they are comparing the performance of these modern engines on trains which have become heavier each year, and are hauled at a much higher average speed than formerly, and consequently the drain on the boiler from this cause, or from the increased weight of the trains, is enormously increased. I have here, for instance, a table of some tests made on one of the divisions of our road, on freight engines; it has no direct bearing on the subject to-day, but shows the effect on the boiler of an increase of speed. The maximum drawbar pull obtainable from the engine is about 22,000 lbs. at the stalling point. Under such conditions, at practically zero speed, the engine was only developing 12 HP.; at the greatest speed for that pull, which was about 10 miles per hour, it was developing 600 HP., and at a speed of 37 miles per hour, with much less pull, it was developing 800 HP. These figures are a measure of the increased drain on the boiler for steam as speed increases. Now, it seems to me, if we think these modern engines do not haul as heavy trains as they should with their weight and size, we might understand it if we took the speed into consideration. In speaking of the Allan valve, I do not notice that Mr. Quereau draws attention anywhere to a common defect of this valve, which is the tendency of the steam to leak across the narrow bridges between the auxiliary and main ports; this leakage can nearly always be detected on the indicator card, and must tend to neutralize the advantages claimed for the valve.

Mr. Marshall.—I believe the orders and general instructions to enginemen should be to run with a wide open throttle under all circumstances except the very extreme ones. It will, in the long run, result in more economy in operation, than to give them the choice of throttling. At the same time if the advantages of hauling an engine in that way are to be realized, the valve gear should be arranged so that the engine will be an easy riding one under those conditions. It is impossible to expect a man to run with an open throttle and early cut-off, if it makes the engine ride hard. The men will argue, and I thing rightly, that the engine is not running economically when shaking itself to pieces. I fell confident that a good many large modern engines have cylinders too large for the work they are designed to do, and that the increased power desired could be obtained by improving the valve gear rather than by enlarging the cylinder.

Mr. Delano.—Upon reading the paper my first thought was that a careful study of simple engines would show that there were chances for economy in them, which would meet the most daring figures of the most enthusiastic man on the subject of compound locomotives. I do not wish to be understood as saying this for the purpose of throwing cold water on the compound idea. It seems to me that the difficulty is that the use of the indicator is altogether too limited in locomotive practice; that it is reserved for use on a few pet engines, or new designs, and that it is not used as it is in marine and stationary practice, on all engines and frequently.

Mr. Street.—In regard to the use of the indicator on locomotives, I think railway men are fast coming to realize the fact that it is not used to the extent which it should be, and my opinion is that master mechanics generally have no idea of the amount of valuable information they can obtain by the use of the indicator. There is a saying that the locomotive is the most wasteful steam engine in use, and I believe one reason for this waste is the fact that the indicator is so seldom used on these machines and therefore little is known about their steam distribution. Mr. Barnes says: "One of the best features of the Stephenson link motion is the increase of lead it gives at short cut-off and high speed." I have never been able to see the great advantage of this increase. In fact, I believe that a good many roads are coming to the belief that the Stephenson link motion gives too great an increase. The Pennsylvania R. R. has, I believe, nearly, if not all, its high-speed locomotives adjusted with a lead practically constant, and I believe that the majority of foreign builders, English, French and German, use locomotives with a constant lead.

Mr. Symington.—The Baltimore & Ohio R. R. has what is known as the Perkins engines. They have a stationary link, which gives a constant lead, and have been running fifteen or twenty years, and do notably better work and make better speed than any other engine of the same capacity.

Mr. Manchester.—We had five engines of the same class put in the same service at the same time; there were two engines that made a particularly good performance for coal and for speed. One of them was run by an engineer who was quite scientific in his manner of handling an engine. He was disposed to work with as short a cut-off and wide open throttle as he could. The other was a man who had no particular knowledge of the principles or proper distribution of steam, but he was a man who had had a great many years of experience on a locomotive, and he could feel and see and hear where a locomotive was doing its best work the easiest. He ran his engine with the throttle and the reverse lever in the position in which the engine would do the best work and make the least annoyance to him. The result was that this engine has led the five during the four years that they have been in service. The one that was run by the man who was quite scientific has been a close second.

Mr. Johann.—I have practised for the last 30 years giving valves inside clearance, according to the nature of the work the engine is expected to do. I took up that subject first in 1863 with Mr. Hudson, who was then superintendent of the Rogers Locomotive Works, and begged him to send me engines with the inside clearance that I wanted, and he declined to do it. We corresponded for about three months and he still persisted in having his $\frac{1}{8}$-in. inside lap. The road was not very solid financially, and we were buying engines with paper, so I could not stand on my dignity about having my engines just as I wanted them. But as fast as the engines arrived at my shop the steam chests were opened and the valves fixed as I wanted them, and they would take two more cars over the hills than they would with the inside lap. I have done that for the last thirty years, and I fully corroborate Mr. Quereau's statement on inside clearance. I have run them with $\frac{1}{4}$-in. inside clearance with entire satisfaction, and economy upon the principle that you want to get the steam into your cylinder quickly and you want to get rid of it equally as quick.

Mr. Forsyth.—I have been looking over the speed diagram of our fastest express train, the Denver Express, on which we made our passenger engine test, and find that although we made only six or seven stops in a run of 163 miles, the engine was accelerating the train from a slow speed to a higher speed during 72 miles, or 43% of that run, so that instead of running at a uniform speed over a good portion of the road, the engine, due to the stops and irregularities, was accelerating the train most of the time. Now I claim that it is this acceleration, due to stops and to places where the engine has to slow down and get the train up to speed again, which calls for the increase in power in high-speed engines, and the thing to do then is not to keep on building larger engines all the time. Higher speed is, as Mr. Delano has said, influenced by track arrangements, and it is a thing for the track people to take up, and reduce the grades, and put in interlocking signals, so as to reduce the number of stops. That is illustrated again, as is probably well known to you, by the difference between the Lake Shore and the New York Central high-speed engines. The Lake Shore engine was small and it did the work successfully because they have low grades on the Lake Shore road, and made very few stops. On the New York Central road they have heavier grades, and they require the heavier engine, though I doubt very much whether they did not overdo the thing and get it too heavy. The most encouraging thing, I think, that we have in the matter of compound locomotives, is this report from the Pennsylvania road, where they show at 70 miles an hour they have developed 914 HP. I think that is the most remarkable record that I ever heard of a locomotive having made. It is the greatest horse power I think that has ever been reported at such a high speed. That has been accomplished with a compound locomotive, and it shows that the distribution of steam in that type may enable us to develop this high power at high speeds where it could not be obtained in a simple engine.

Mr. Quereau.—I think President Forsyth is in error in saying the requirements of power are not as great at high speed as at low speed. It is the requirement on the boiler. An engine runs twice as many cylinder pulls in an hour at a speed of 60 miles an hour as at 30. Assuming that the power is the same for both speeds, the demand on the boiler at 60 miles an hour is just twice what it is at 30 miles an hour in a given time, say one hour. As to the increase in lead, if the lead is properly adjusted for high speed it will be too much for low speed. Your engine will be loggy and the rods will pass the centre with a thump every time; at least that is my experience and that of some others.

Discussion on this subject was closed, and a report on alterations in the rules of interchange was read by Mr. Peck.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF PHILADELPHIA.
April 7. Secy., L. F. Rondinella, 1122 Girard St.
SWEDISH ENGINEERS' CLUB.
April 7. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 106 Randolph St., Chicago. Secy., C. T. Anderson.
WISCONSIN POLYTECHNIC SOCIETY.
April 9. Secy., M. F. Schinke, City Hall, Milwaukee.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
April 10. Secy., F. C. Osborn, Case Library Building.
NORTHWEST RAILWAY CLUB.
April 10. Secy., W. D. Crosman, Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
April 10. Secy., D. W. McMorris, Burke Blk., Seattle, Wash.
DENVER SOCIETY OF CIVIL ENGINEERS.
April 10. Secy., F. E. King, Jacobson Block.
AMERICAN RAILWAY ASSOCIATION.
April 11. Secy., W. F. Allen, 24 Park Place, New York.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
April 11. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
April 11. Secy., F. M. Curtis, P. O. Box 1576, Boston.
AMERICAN SOC. OF MECHANICAL ENGINEERS.
April 11. Secy., F. R. Hutton, 12 W. 31st St., New York.
ENGINEERING ASSOCIATION OF THE SOUTH.
April 12. Secy., Hunter McDonald, Nashville, Tenn.
ENGINEERS AND ARCHITECTS' CLUB OF LOUISVILLE.
April 12. Secy., G. W. Shaw, Norton Building.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
April 12. Secy., C. H. McLeod, Montreal P. Q.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
April 12. Secy., D. W. Meeker, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
April 14. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
April 14. Secy., Waterman Stone, Baird Building.
ENGINEERS' CLUB OF MINNEAPOLIS.
April 16. Secy., E. Nexsen, 504 Kasota Block.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
April 17. Secy., Daniel Carhart, Pittsburg.
WESTERN RAILWAY CLUB.
April 17. Secy., Clement F. Street, Rookery, Chicago.
COLUMBIAN ENGINEERING SOCIETY.
April 17. Secy., F. W. Hart, Washington, D. C.
BOSTON SOCIETY OF CIVIL ENGINEERS.
April 18. Secy., S. L. Tinkham, 36 Bromfield St.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
April 18. Secy., J. A. Pilcher, Roanoke Va.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
April 18. Secy., F. Collingwood, 127 E. 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS.
April 18. Secy., Wm. H. Bryan, Turner Bldg.
NEW YORK RAILROAD CLUB.
April 19. Secy., John A. Hill, Temple Court.
ENGINEERS' CLUB OF CINCINNATI.
April 19. J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
April 19. Secy., Howard Berge, 100 Washington St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 19. Secy., S. A. Charpiot, Macon, Ga.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
April 20. 201 Washington Building.
CENTRAL RAILWAY CLUB.
April 25. Secy., S. W. Spear, Buffalo, N. Y.
WESTERN SOCIETY OF ENGINEERS.
May 2. Secy., Thos. Appleton, Lakeside Bldg., Chicago.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
May 4. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
May 4. Secy., O. Von Geldern, 719 Market St., San Francisco.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
May 7. Secy., C. L. Annan, City Engineer's Office.
MASTER CAR BUILDERS' ASSOCIATION.
June 12, 16. Saratoga, N. Y. Secy., J. W. Cloud, Rookery Building, Chicago.
MASTER MECHANICS' ASSOCIATION.
June 19, 23. Saratoga, N. Y. Secy., Angus Sinclair, Temple Court, New York.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.
Entered at the Post Office, New York, as Second Class Matter.

VOL. XXXI. THURSDAY, APRIL 5, 1894.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS.
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER,.....ASSOCIATE EDITORS.
GEO. H. FROST.....BUSINESS MANAGER.
F. P. BURT.....ASSISTANT MANAGER.

CHICAGO OFFICE: 1,636 The Monadnock.
CHAS. S. HILL.....RESIDENT EDITOR.
F. A. PECKHAM.....ADVERTISING MANAGER.

EUROPEAN AGENCIES:
KEGAN PAUL, TRENCH, TRUBNER & Co. (Limited), Paternoster House, Charing Cross Road, London, Eng.
SAMPSON LOW, MARSTON & Co. (Limited), St. Dunstan's House, Fetter Lane, London, Eng.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 3 months, $1.00; single copies, 15 cents. To all other countries in the Postal Union, add $2.08 per annum (4 cents per number) to above prices for postage. No club rates allowed. Mailing addresses may be changed at will by sending both old and new address. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The date when the subscription expires is on the address label on each paper: the change of this to a subsequent date is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The importance of tight joints in sewers is being brought home to engineers and others interested in the drainage and sanitation of cities more and more forcibly with the extension of the separate system of sewerage the rapid additions to the number of sewage purification plants and the increasing length of outfall sewers made necessary by the demand that sewage shall be put where it will cause the least possible offense. With the combined system of sewers, a considerable amount of infiltration is expected and, comparatively speaking, is of much less significance than in a separate system, owing to its small proportion to the carrying capacity of the sewer. But in a separate system the water of infiltration sometimes forms a large part of the full flow of the sewer; and while it has but little effect upon the necessary size of the laterals it may materially increase the required size of the main outfall, if not some of the trunk sewers. Still, even here the amount of infiltration is small in importance compared with what it is when the sewage is disposed of by any other method than discharging it untreated into a natural water course. The volume of the sewage is one of the most important elements in connection with the cost of constructing and operating a sewage purification plant. A diluted sewage may be more easily purified than a concentrated one, but an increased volume of water means that more land will be required for either intermittent filtration or broad irrigation, while with chemical precipitation a greater tank capacity is necessary, although an increase in the amount of chemicals or in the resultant sludge does not necessarily follow. Wherever in connection with sewage purification plants or other methods of disposal the sewage must be pumped, of course the addition of ground water to sewage is again a serious matter.

Considering the importance of this question there is a regrettable dearth of information in print as to the best forms of joints to exclude ground water, and as to the amount of leakage which actually occurs in sewers laid in wet ground. In view of this fact, we trust that any of our readers who may have experience bearing on this subject in their possession will report it for the general benefit of the profession. In this connection we would call attention to a rather promising sewer-pipe joint of English design, which is illustrated elsewhere in this issue.

Under the operation of our patent law there is on Friday of each week an issue of several hundred patents on which the final fee has been paid during the week preceding. At the present time the issue runs about 500 per week. Inasmuch as this practice is an old one, and as the legal term of a patent is 17 years, except as it may be shortened by the expiration of foreign patents of earlier date, it necessarily follows that a large number of patents will also expire each week. Except for changes in the volume of patent office business, the number of patents expiring would be the same number as are issued, but inasmuch as the number of patents issued is now about double what it was 17 years ago, there are actually only half as many patents expiring as are issued. To record these patents the government has since 1872 issued a weekly "Official Gazette" and sundry other more elaborate publications, so that if any one wishes to know what patents are expiring all he has to do is to turn back to the "Official Gazette" of 17 years before, and he will find both those which have expired and those which are about to expire within any desired period. These past volumes are all in print, and can be obtained by any one who wants them or they can be consulted gratis in thousands of public and private offices. No one has any particular occasion to consult such a list as a whole, however. It is often of importance to determine when particular patents expire or when those on record relating to any particular art will expire; but for this use a list of all those which expire on any particular date is of no service whatever.

Under these circumstances it is difficult to conceive of a more senseless waste of public money than is involved in a recent innovation of the Commissioner of Patents under which there is added each week to the "Official Gazette" giving the new patents a photographic reproduction of the issue of 17 years before, showing the patents which expire the same week. It makes a nice plum for the contractor for printing, no doubt, and it is openly charged that this was the intent of the innovation, a charge which certainly has this much to support it, that it is difficult to see how any other human being can be benefited by the publication, while the public at large is inconvenienced by it from the fact that the bulk of the weekly pamphlet is increased one-fourth. The absurdity is increased by the fact that the list must, in the nature of things be incomplete, because patents are continually expiring in advance of their natural life in this country because of the expiration of foreign patents of earlier dates, so that when many patents are thus at last resurrected before a forgetful world they may have been dead for years. Moreover, this is actually the case in respect to most of the reissue patents thus resurrected, all of them in the issue now before us (March 13) having been dead from one to thirteen years. Thus, reissue No. 7,557 was for a saddle cloth, which was originally patented March 15, 1864, and the patent on which expired consequently March 15, 1881, since a reissue does not extend nor affect the life of a patent. It was reissued, however, April 25, 1871, and again reissued March 13, 1877, and it being now 17 years since this latter reissue, our saddle cloth is duly pictured and described under the misleading title "Patents Expired March 13, 1894," though it actually expired 13 years ago!

In the apparent hope of justifying this new folly before the public, some one has begun the custom of furnishing to the press a weekly selection from the list, prefaced by the stereotyped phrase "A large number of important patents expire this week," etc., as if this were something unusual. Many guileless journals have been caught in this ingenious trap, and duly published this list, but we are glad to observe that most of them are already "onto" the humbug of it, and have ceased to give space to this list.

The anomaly of wasting the patent office funds in the manner above described is the more striking in view of the chronic poverty with which the office has for years been contending. The crying needs of more room for the office force, and for filing important documents, of a larger staff to reduce the long delays which now occur before action on important inventions is taken, and of better salaries to the members of that staff in the higher grades—all these needs have been matters of common knowledge for years, and have been set forth in the annual reports of one commissioner after another. Only the most prudent and careful husbanding of the yearly appropriations which Congress has made has enabled the office to keep up to its work with even a passable degree of success during the past dozen years. In 1892 the cost of publishing the "Official Gazette" was $55,668. Apparently the increase of this cost due to the republication of the issues of 17 years ago will amount to some $12,000 per annum. This is not a large sum, it is true, but judiciously expended it could effect no small improvement in the onerous conditions under which the office force now performs its work. It may be noted also that the total expenses of the patent office of every sort in 1892 were only $831,693. The useless increase in the cost of the "Official Gazette," therefore, will effect an increase of some 1½% in the total annual expenditures of the office, which should be enough to enable the office to keep its work up to date instead of being some months behind. It is certainly to be hoped that this needless bill of expense may be abolished and may not become a permanent addition to the patent office expenses.

The question of corporate and private ownership of tramway lines has led "Engineering" to investigate the extent and financial results of the tramways throughout the United Kingdom. According to that journal, of the 960 miles of tramways in operation, only 274 are now owned by the local authorities and in nearly all cases these are operated under leases. The capital expenditure on these lines is a little over $70,000,000, or nearly $75,000 per mile, including equipment and buildings. Our contemporary notes that the lines owned by corporations are usually of greater extent than the individual privately owned lines, and that the average cost to the corporation is about $56,750 per mile, including buildings and equipment, as against over $80,000 per mile for the private line. While it can be imagined that a company requires a greater floating capital than a municipal corporation, it is suggested that in the case of municipal lines the paving is not charged to the cost of the tramways, while it is charged to the private line. In England and Wales, with 761 miles of line, the paid-up capital equals $73,250 per mile; in Scotland, with 86 miles, this is $75,000 per mile, and in Ireland, with 113 miles, it is only $56,000 per mile. Within ten years the capital expended on such lines has increased from $41,250,000 to over $70,000,000. The traffic in this ten years has more than doubled, being now 598,250,000; and as the cars number 4,098, each car averages 149,800 passengers per year, or 428 for each day of 350 days in the year.

The relation between receipts and expenditures, however, is the chief point of interest, and on this point our contemporary reports as follows: The returns for 1893 show that for carrying this 598,250,000 passengers the sum of $18,030,475 was received, or about 3 cts. per passenger. The working expenses absorbed nearly 80% of the receipts, or $14,187,230, so that the net result would afford about 5½% on the paid-up capital, without allowing for depreciation of ways, plant and stock.

With regard to the relative economy of operation, between corporation and private lines, it is difficult to determine this point positively, says "Engineering." Three cities are returned as working their own system. The Blackpool Electric Tramway, 1 mile and 79 chains long, earned $24,275 and expended $17,370. As the capital is $144,820, the return is not as good as the average for the kingdom and each passenger paid nearly 4 cts., instead of 3 cts. Whether the reduced profits are chargeable to municipal working or to electric traction does not appear. At Huddersfield, where mechanical power is also used on 18½ miles of line, the expenses were $96,395 out of an income of $121,145; and the return was about 3¾% on the capital. The Birmingham system is the most important in experience, because on its 25 miles of line, steam, horse, cable and electric methods of traction are employed. In this case the working expenses are

75% of the receipts, the income being $773,420, or $30,935 per mile. In Glasgow, the receipts are $43,500 per mile, but the expenses figure at 80%. An interesting statement is made in the Birmingham report, to the effect that the cable tramway absorbs barely 50% of receipts for ordinary working expenses; the electric tramway practically absorbs all the receipts; the steam tramway requires 70%, and the horse considerably more. In neither case is direction, management, or rent considered; and as traffic and the conditions of working are not duly regarded these figures are not of themselves a fair basis of relative results. In conclusion, "Engineering" says that the private companies have generally operated their systems most satisfactorily; and corporations are advised to weigh well all considerations before entering upon similar enterprises simply because they conform by *so* doing to some present ideas as to municipal socialism.

The failure on March 30 of a large stand-pipe at Peoria, Ill., noted elsewhere in this issue, is the second notable disaster of this kind which has happened during the first three months of the current year and arouses anew the query: "Why are stand-pipe failures so frequent, and what can be done to prevent them?" There are now seven or eight hundred stand-pipes in the United States, and their number is rapidly increasing. If stand-pipe failures were generally accompanied with such loss of life as was the case at Peoria "the deadly stand-pipe" would soon become a current phrase. An important problem is certainly presented to engineers to determine the reasons why these failures occur.

A year or more ago Prof. Wm. D. Pence, of the University of Illinois, undertook a thorough investigation of all the stand-pipe failures which have occurred in the United States, and by personal correspondence and inquiry, supplemented by exhaustive researches through technical literature, collected a complete history of such failures. We are pleased to be able to present to our readers in this issue the first part of the valuable monograph which Professor Pence has prepared on this subject. Seldom have the failures of a single class of engineering structures been so carefully and completely examined, and we are sure the records he has collected with so much labor will be fully appreciated by all our readers interested in this subject.

THE BEARING POWER OF PILES.

A correspondent calls our attention anew to an article recording some "Tests of Bearing Power of Piles," published by us in our issue of July 6, 1893, and reminds us that the interesting records given in that article demand some further attention from us, to the end of determining how closely the actual records there given correspond with sundry other facts and formulas which have appeared in these columns, and especially with the formula for the safe load of piles first propounded in this journal, and which has accordingly become somewhat widely known as the "Engineering News formula."

This formula is: Safe load $= \frac{2\ Wh}{s+1}$, in which W = weight of hammer in the unit in which the safe load is desired, h = fall of hammer in feet, and s = mean set of pile under last few blows.

For the reasons given below this was modified in our article published Nov. 17, 1892, giving a code of rules for pile-driving into the form, for code of rules for pile-driving, into the form, for Nasmyth steam pile-drivers:

$$\text{Safe load for steam pile-drivers} = \frac{2\ Wh}{s+0.1}.$$

The records published in our issue of July 6, 1893, although reporting tests by loading extended only to a single loading of four piles, are as a whole among the best on record for determining the actual value of pile-driving formulas, because they cover the actual penetrations of a large number of piles, both when first driven and after rest, and driven with a steam pile-driver and with a common pile-driver in tolerably homogeneous soil, and because they give the actual load which it was found the piles would sustain, and the fraction thereof which it was deemed safe to rely on. The tests were made on the site of and preparatory to driving the piles for the foundation of the new Chicago Public Library building, and the main facts given in our original article may be abstracted as follows:

Piles driven 2½ ft., centers, three in a row, driven about 52½ ft. in all, 27 ft. in soft plastic clay, 23 ft. in tough compact clay, 2 ft. in hardpan. Specified limits of diameter, 8 ins. least, to 16 ins. greatest. Average diameter at butt, 13 ins., at point, 10 ins., or 80 sq. ins., average area of bearing surface at tip.

Estimated supporting power of hardpan, 170 to 250 lbs. per sq. in., say, 200 lbs., or 16,000 lbs. on tip only.

Estimated side frictional resistance, alleged to be experimental, 15 lbs. per sq. in. on an average surface of 25,000 sq. ins., giving 375,000 lbs., or 383,000 including load on tip.

Estimated crushing strength of wet Norway pine, 1,600 lbs. per sq. in. × 80 sq. ins. = 128,000 lbs., or × 113 sq. ins., the estimated mean sectional area = 180,800 ultimate crushing load.

Actual test load sustained without sign of settlement by each of four piles, 101,200 lbs. for 14 days.

Actual load placed on each pile, 60,000 lbs. = 15.3% (say, 1-6 of estimated frictional bearing power, 34.2% (say 1-3) of estimated crushing strength, 59.2% of load actually sustained, and 66.7% of estimated safe load, 90,000 lbs.

Observed sets under last blows in decimals of an inch:

Under 4,500-lb. Nasmyth steam hammer, 42-in (3.5 ft.) fall:	
With oak follower, 48 to 64 blows per ft., or per blow	2 ins.
Without follower, 24 to 32 blows per ft. estimated, or	0.25 to 0.19
After 24 hours' rest, same piles and hammer:	0.50 to 0.37
With follower, 300 to 600 blows per ft., or	0.04 to 0.02
Under 3,000-lb. drop hammer, falling 30 ft.:	
With follower, 16 blows per ft., or per blow	0.75
Under same hammer, with 15-ft. fall:	
With follower, 32 to 36 blows per ft., or per blow	0.38 to 0.34

The only facts not given here which it would be desirable to know are the precise condition of the heads (which was probably fair) and the length of the follower. It is stated as a fact that the "ratio of blows (to cause 1 ft. penetration) without follower to blows with follower is as one to two," and our correspondent whose inquiry has led to this article asks if this is correct. It is impossible to say. It is a question of fact, since all analytical discussions of this question are of little value. As a mere question of dynamics, it should make no difference whether the follower is a separate piece of wood or is a part of the pile itself, but practically it does make a great difference. Again, the absolute mass of the pile should make a considerable difference in the penetration, but practically it seems to make very little difference, if the conditions are otherwise similar.

Proceeding now to determine what sort of a guide as to the proper loading on these piles an engineer would have had who relied solely on the above-quoted formulas, we have the following. It is not necessary to reproduce the computations as the formulas are so exceedingly simple:

Safe loads given by formula:	
Driven by steam hammer, with follower	87,200 to 107,000
Driven by steam hammer, without follower	52,500 to 67,000
Driven by drop hammer, with follower, 30-ft. fall	 103,000
Driven by drop hammer, with follower, 15-ft. fall	65,330 to 67,450
Actual load used in construction	60,000
Actual loading sustained without sign of yielding	101,200
Estimated ultimate bearing power without crushing	180,800
Estimated ultimate frictional bearing power	393,000
Estimated actual resistance to penetration during driving (= 6 times the above safe loads)	360,000 to 600,000

(The last line is deduced only from the formula, and it is to be remembered that the hammer blows do actually crush the wood at both ends.)

It would be unreasonable to ask or look for any closer correspondence of such a formula with fact than these figures show, while the close correspondence between the formula results with the steam hammer and the drop hammer is both gratifying and surprising. Records of this kind in which the two methods of pile-driving can be accurately compared with each other are extremely rare; in fact, we recall no other but this, and in comparing the figures it is to be noted that the piles as actually driven were driven with follower, and that the equivalence given for corresponding piles driven without follower is perhaps largely hypothetical. We infer from the record that the same is the case with respect to the figures given for 15-ft. falls of a drop hammer, though doubtless in each case tests were made which make the figures given more or less legitimate inferences. If almost any other formula for loading piles which has ever been proposed be compared with these records it will be found that it is much more erratic and less trustworthy, giving loads considerably in excess of all reasonable warrant. The one which compares best of all, so far as we have checked them, is Trautwine's, leading us to believe that that eminent engineer largely based his formula on comparative results with a steam hammer and drop hammer, though that fact is not stated in his comments on it.

Safe Loads by Trautwine's Formula for above Piles.

	Ultimate.	Safe, for factor ¼.
Steam hammer with follower	281,000 to 295,000	70,250 to 73,750
Steam hammer without follower	235,000 to 257,000	58,750 to 64,250
Drop hammer, 30-ft. fall	274,000	68,500
Drop hammer, 15-ft. fall	276,000 to 287,000	69,000 to 71,750

We adopt ¼ as the factor of safety for comparison because that would be our legitimate inference under the given conditions from Mr. Trautwine's directions, had we been relying upon them only for determining a safe load on piles. These particular piles could hardly be said to be "thoroughly driven in firm soils" (in which case the factor would have been ½, giving twice the above loads) nor driven in "river mud and marsh" (which would call for the factor 1-6, giving only two-thirds of the above loads), but something betwixt and between, naturally calling for a factor of about ¼. Such a conclusion would in this case give an engineer a safe and good guide to the proper load. If "subject to tremors" Trautwine would reduce all these loads one-half, which would give unreasonably small loads, but the building could hardly be said to be subject to tremors.

Whether or not we are correct in our surmise that the peculiar form of Trautwine's formula, employing the cube root of the fall instead of the fall itself in the numerator of the formula, was deduced in an effort to make it fit steam hammer and drop hammer work alike, it is evident that it does so fairly well, but it does not therefore follow that the formula is a fit one to use. On the contrary, these very facts, when carefully examined, show that the formula is unphilosophical and unfit for use; which we urge, of course, from no lack of respect for Mr. Trautwine's work, but in accordance with what was his own consistent spirit, to seek for the best in practical result, and be content with no less.

It is an admitted and certain fact that the dynamic effect of the short, quick blows of a steam hammer is greatly more in comparison with the slower blows and higher falls of a drop hammer than their comparative foot-pounds of impact energy would warrant. Mr. Trautwine's formula assumes in effect that this superior efficiency is due to the shortness of the fall, whereas it is in fact due to the quickness of the blows. This we should very soon find out if we were to take a 4,500-lb. drop hammer, and drop it 3½ ft. precisely as the steam hammer drops, but with the same long interval between blows as the ordinary drop has. Mr. Trautwine's formula implies that these two piles will have precisely the same bearing power for the same set per blow, and as the set per blow under such blows is a very small part of the denominator of his formula, it would give very nearly the same safe load for both of them regardless of their set, while as a matter of fact the steam-driven pile would be good for several times as heavy a load as the drop-hammer pile, because the latter, if driven with slow blows and a drop of only 3½ ft. would hardly be safe for any considerable load. It would be a great public benefit, and a quite inexpensive one, if some one would make a few tests to determine this fact experimentally, or rather, to determine its limits, for of the fact itself there can be no doubt.

The true conclusion, and the true method of

constructing pile-driving formulas, we may reach thus: It is a certain fact with which all records are consistent, that any rest between blows increases the resistance to the next blow by enabling the material to settle around the pile, and so produces a friction of rest which is greater than the friction of motion; and it is also certain that this effect increases in some ratio with the length of the rest. This is clearly shown in the record given above, where 24 hours' rest of a pile increased the number of blows required per foot of penetration from six to tenfold. If we had no such extra friction of rest, as we should not have with a pile-driver arranged to give blows in triple-hammer fashion, the next blow falling just as motion from the last blow was ceasing, theory and experience combine to indicate that the proper formula would be something like this in form: Safe load for continuous blows $= \frac{2\,Wh}{s} = 1.6\left(\frac{12\,Wh}{s}\right)$ the numerator of the fraction expressing the dynamic energy of the blow, and the denominator the distance through which this energy causes motion. The quotient therefore must be the mean resistance to that motion or (with a safety factor included) some fraction thereof. If there be no intervals of rest, but continuous motion, the resistance also will be sensibly uniform in uniform soils.

If, now, we deliver these same blows slowly, the dynamic energy of the blow still remains the same, and therefore the numerator must remain constant in any philosophically constructed (i. e., trustworthy) formula. On the other hand, the mean resistance to the blow is abnormally increased by an amount which seems to vary quite directly with the interval between blows. Overcoming this initial extra resistance is a substitute dynamically for causing some extra penetration, and therefore the denominator s, which expresses the actual penetration, must be expressed by some addition to s, AND that addition must be constant for the same interval between blows, because it expresses an addition which varies with that interval, but not with the subsequent penetration, which varies with the total energy of the blow. In any one given method of driving piles the interval between blows is sensibly constant; therefore the constant addition to s should always be the same for the same method of driving, or the formula becomes unphilosophical. On the other hand, if the method of driving be materially changed with respect to frequency of blows, the constant also must change, or the formula again becomes unphilosophical.

It chances that, for the ordinary drop hammer, which is most used, the constant 1 (which simply says in effect that the initial resistance is about equivalent to an extra inch of penetration after the pile is once in motion) conforms very well (1) to the facts of record, which is important, and (2) to theoretical considerations as held by some persons, which in itself is a fact of no importance, but as confirmatory evidence has its use. It is quite certain that, in an absolutely perfect formula, this constant 1 would vary somewhat with the precise interval between blows and the precise character of the soil. It is claimed only (1) that these variations would be small; (2) that they would probably be of about equal amplitude on each side of 1; (3) that there is no possible way of determining or guessing at what they should be short of test in each case; (4) that no other conditions than the blow interval and nature of soil can have any possible effect upon the constant in a philosophical formula. Therefore, the constant should remain a constant for the same method of pile-driving. If we wish to be a little more or less cautious in respect to the load we place on the pile after it is driven, whether because of the character of the load or the importance of the structure, that is an after consideration, having no possible pertinence in the formula itself.

On the other hand, if we change our whole method of pile-driving into one which makes the blows 10 or 20 times as frequent, the same considerations which before required that the formula should be constant, require that it should be materially decreased for the new method of pile-driving, but should remain constant under all other conditions in that method. Hence the modified formula for the steam pile-driver given above. For analogous reasons, fully explained in our code of rules published Nov. 17, 1892,* we have for gun-powder pile-drivers the still further form: Safe load for gun-powder pile-drivers $= \frac{4\,Wh}{s+0.1}$.

These three forms together are supposed to meet all requirements for any method of pile-driving by blows, but one must not be used for the other, because no possible formula which is trustworthy under all conditions for any one method of driving can be at all trustworthy for the other two.

LETTERS TO THE EDITOR.

MOVEMENT OF TRACK ON A STREET RAILWAY.

Sir: I would like to call attention to a fact which may be of interest. In our town, where an electric railway has recently been put in operation, there has become noticeable at one of the street corners a peculiar bending of the track—the tangent, instead of leading directly into the curve, first taking a bend away from the center, just before reaching the P. C., and then reversing into the true curve, making an apparent sharpening at each end thereof. At this point the track is located on made ground and this sharpening of the curve appears to be attributable to the reaction of the wheels against the track at the beginning of the curve, having pushed it out from the line of the tangent. C. M. B.

Media, Pa., March 26, 1894.

CLAMP MOLDS FOR POURING LEAD JOINTS.

Sir: Referring to the description of a clamp for pouring lead joints, in your issue of March 22, 1894, the device is essentially so like the Watkins patent pipe jointer (for illustration of which see Ripley & Bronson's catalogue of 1891, p. 175) that I should think it would probably be held to be an infringement. If not, the writer would be glad to know it, as the Watkins jointer is sold at a pretty high price, notwithstanding which it will soon pay for itself in competition with the old clay roll.

Respectfully, E. K. Blanchard.

St. Louis, Mo., March 24, 1894.

(An examination of the illustrations of the two devices shows them to be similar in general principles but different in detail. Whether or not one is an infringement on the other we cannot undertake to say. In the article referred to above it should have been stated that "the device is not entirely original" with Mr. Phillips, the omission of the word "not" being a typographical error, as the context shows. The Watkins jointer is listed in the above-named catalogue at from $3 for 3-in. to $40 for 48-in. pipe. Ripley & Bronson are located at St. Louis, Mo.—Ed.)

"SIGNAL-LADIES" ON THE CHESAPEAKE & OHIO RY.

Sir: Herewith I inclose an interesting letter from Mr. J. W. Gill, Superintendent Western Division, Chesapeake & Ohio Ry. You will note from this a new occupation for women. It is certainly very conclusive evidence of the case with which a mechanical plant can be operated. This goes one better than the plant recently described, operated by a one-armed man. Yours truly, H. M. Sperry,

General Agent Johnson Railroad Signal Co.

(Certainly woman cannot much longer be designated as "the weaker vessel." "Salesladies" we have long been familiar with, and "signal-ladies" are now come. Another rather amusing evidence of the activity with which women are urging their claims to recognition in industrial pursuits, is given by one of Chicago's elevated railway companies, which has posted conspicuously on its office doors the following placard in large letters. "This Company Has Decided to Employ Men Only in Operating Its Lines."

The letter inclosed by our correspondent is appended.—Ed.)

Sir: Replying to your favor of the 31st ult., will say that at present we have three points on the Greenbrier Division of this road where lady operators are required to attend the switches. At Rockland, one lever moves both switches of the cross-over and it is operated without any effort. At Wolf Creek, one lever throws two switches, two detector bars and two locks; this lever is rather stiff on account of not being used very frequently, but the operator has no trouble in manipulating it. At Lowell, the levers are not loaded at all heavily and of course they work very easily.

When these machines are put in properly and kept cleaned and well oiled, there is no difficulty whatever in lady operators handling them very successfully. We have one or two machines at other points that are handled by lady operators without any difficulty whatever. In fact, I do not see but what they do the work as well as at any other point where men are employed. Yours truly, J. M. Gill.

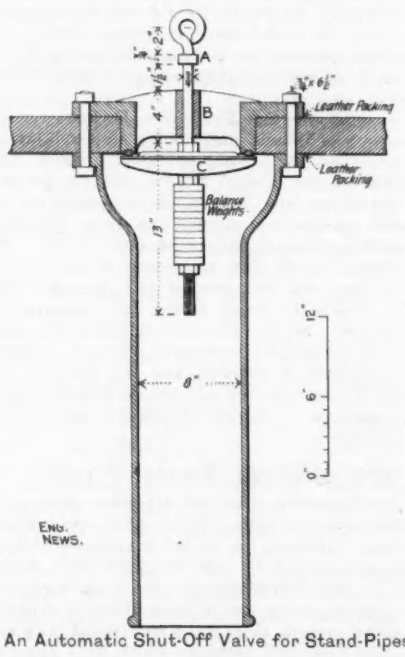
* Republished in "Piles and Pile-Driving," Eng. News Pub. Co., $1.

AN AUTOMATIC SHUT-OFF FOR STAND-PIPES.

Sir: We are interested in your issue of Jan. 4, 1894, as usual, and in this issue we are particularly interested in the editorial note in regard to the delivery of water at high pressure for domestic purposes. There is in the note food for water-works superintendents and others in authority to "chew" upon for some time to come.

Referring to the latter part of this editoral where you say: "Heretofore when pumps have been cut off from stand-pipes or reservoirs, the cutting off has generally been done by hand by closing a gate valve, etc.," and your reference to an illustrated article on a separate page, describing "An Excess Pressure Retaining Valve," which is very ingenious, we are desirous of calling your attention to the fact that there has been a much simpler device in use for some years, a blueprint of which we are pleased to inclose to you herewith, and that although this company has something over a hundred of these valves out, yet we have not a complaint on record, and to the best of our knowledge there has not been a failure in the operation of the valve.

Its simplicity will be apparent with the following brief explanation: The valve C in its normal condition descends until the shoulder A on the upper end of the valve stem rests upon the guide or bridge, B.



An Automatic Shut-Off Valve for Stand-Pipes.

The valve stem is extended below the valve to receive the adjusting weights to keep it in balance. Attached to this valve from above is an inexpensive galvanized iron float or copper ball.

When pumping into the stand-pipe or tank with an ordinary current of water, the valve is inoperative until the receptacle is full, when the float pulls the valve up against its seat and any further pressure tends to keep the valve closed more firmly.

A water relief valve or safety valve at the engine a mile or more away notifies the engineer that his reservoir is full; or the work can be done automatically and by the application of power thus closed without the aid of a man, as is done in hundreds of instances to our knowledge. It is obvious that the relief valve should be set at a slightly higher pressure than that given from the altitude of the base of the tank or stand-pipe. This keeps, say, 15 or 20 lbs. greater pressure on the pipe line than will come from the reservoir.

The first time a hydrant or faucet is opened connected with this pipe line, the greater pressure is thus relieved and the valve is free to drop into its normal position and the water again flows immediately from the reservoir without interference. The valve acts in either case with the current. If it is important to have the pumps operate as soon as the valve is released, the automatic arrangement at the pump again comes into play, and the pumps will be instantly started.

To the best of our knowledge, after several years' experience with the valve, it will give the very best of satisfaction wherever it is preferable to use the

same pipe for inlet and outlet. In regard to shutting off a half-full stand-pipe in case of an outbreak of fire, the engineer has simply to throw his throttle wide open, when, if the valve is properly adjusted in the first place, the greater current of water seats the valve within 30 seconds and fire pressure can be maintained without danger of water hammer and without delay, two important considerations. You will readily see the simplicity of the device. Very truly yours,

U. S. Wind Engine & Pump Co.,
T. W. Snow, Asst. General Agent.

Batavia, Ill., Jan. 17, 1894.

(This device is simpler than the one described in our issue of Jan. 4, but, like it, makes no provision against water hammer upon the sudden closing of the valves.—Ed.)

THE METRIC SYSTEM.

Sir: With reference to your interesting editorial in your issue of March 1 on decimal measurements, pp. 178 and 179, I think what we have to contend with in passing to and from the English and metric systems is the fact that there is no exact "rate of exchange" between the two. That is, we cannot go from one to the other in even figures. If there were an exact equivalent for the inch, for instance, in the metric system, all the trouble would vanish, and the two systems would be practically identical, except as to nomenclature. It is unfortunate that this is not the case, and somewhat irritating to think how very near they come to it without actually getting there. All that would be necessary to accomplish this very desirable result would be that the meter should contain exactly 40 ins., instead of about 39.37. In approximate reductions I think this equivalent is usually accepted; at least it is what I use in such cases. It is founded on the basis of 1 in. = 2.5 centimeters. To show how nicely all usual measurements agree when this "rate of exchange" is adopted, it is only necessary to reflect that by it 10 cm. = 4 ins.; 30 cm. = 1 ft., etc. We would then have a simple practical rule to turn centimeters into inches, viz.: Multiply by 4 and divide by 10; to turn meters into feet, multiply by 10 and divide by 3. These operations, which can often be performed mentally, are of course reversed in going from feet and inches to meters and centimetres.

centimeters. Very faithfully yours, E. S. G.

Habana, Cuba, March 7, 1894.

(Undoubtedly it would be easier to turn meters into feet if the metric system had been based upon the foot, but it was not, and most certainly will not be. To modify the foot slightly, so as to base it on the meter, is even more hopeless, because it would involve most of the inconveniences and few of the advantages of the metric system, which latter is superior to the foot system, not only in being decimal, but also in the absolute values of the most used units. This is especially true in shop work, where there is the most opposition to the introduction of the metric system, because of the stock of patterns on hand and the temporary inconvenience. No units which the ingenuity of man could have devised could well be worse than the foot, inch and vulgar fractions of an inch, and no unit which the ingenuity of man could devise could well be better than about the length of the millimeter, or 1-25 in. The result is that neither fractions nor decimals are called for in any ordinary mechanical drawing. A distance of 20 ft. is recorded simply as "6096" (mm. understood), and a distance of 1 9-16 ins. as "39," and that is the end of it. Similarly, if we are dealing with micrometer measurements, a single decimal gives us accuracy within 1-250 in. If some benevolent despot could force an immediate change to this standard, it would be greatly to the advantage of all interests in the end, and all real inconvenience due to unfamiliarity with the units among shop workmen would be over in a month or two; but whether the change will ever be made by voluntary action is another and much more doubtful question.—Ed.)

THE EXPANSION OF ICE.

Sir: The ice in the Kennebaccasis River, New Brunswick, Canada, is observed to shove, or heave, towards the northward, piling up on the shore sometimes as high as 7 ft. The following explanation of the movement and its direction was, in substance, offered by Mr. Murdoch, a writer in a local paper, and may be of interest to some of your readers:

Lake or river ice, when freezing, expands in the direction of least resistance, which is into the air; and the first sheet of ice thus formed is a perfectly fitting cover, and fashioned to the form of shore. From this stage onward, fluctuations occur with every change of temperature below 32° F., at which temperature the ice is in its most bulky state. Mr. J. W. Dumble, of Coburg, Ont., who, in the winter of 1859, made observations on a large sheet of ice,* ascertained that the shrinkage after first freezing, or the first movement of the ice, amounted to 0.0000033 of its entire length for each degree of temperature below 32° F. But after this first movement, the variations, whether of expansion or contraction, were found to be uniformly 0.00000765 of length of ice per degree of temperature.

The change of temperature of ice confined between shores causes cracks. Even though the ice be free on one shore (usually the northern), its inertia is so great that when shrinkage takes place, the brittle ice breaks with the loud report heard on rivers and lakes when the air is cooling. It may be noted that actual shrinkage of ice is seldom reported.

It is also true that when the surface of ice becomes unduly heated at any point the ice expands so quickly as to rend the colder parts and form cracks.

However the crack is formed, it fills at once with water, and the water promptly freezes, increasing its bulk 1-11, and tending to push the flow apart by the force of its expansion. When the temperature, local or general, rises again, the ice cake expands to its former extent, plus the aggregate width of all the cracks formed during the shrinkage. Thus, the forming of cracks and the filling of cracks with new ice explains the observed process of growth which takes place with each change of temperature.

When the ice is so firmly fixed to both shores as to prevent movement, the growth just mentioned will cause a piling up of the ice at certain points of the field, determined by local characteristics. At the region mentioned, where the movement was observed, the north river bank is bold and tree clad, and protects the ice from cold, north winds, and aids in concentrating the heat of the sun; while the southern bank, mostly in shadow, is exposed to the north winds. The climate of the north bank, being thus milder than that of the southern, the movement of the ice to the north is favored by the weakened ice on the northern bank. Boulders in a shallow lake in the vicinity were observed to have ploughed furrows in the beach northward under the influence of this ice growth.

The amount of this ice growth for the 111 days of the winter season, during which the average daily range of temperature is over 13°, may be computed to be 30 ft., thus:

13° × 111 days × 2,500 ft. × 0.00000765 =	27.6 ft.
Add 1-11 for expansion of ice in cracks.....	2.5 ft.
Total expansion.....	30.1 ft.

where 2,500 ft. is the width of the river at that point, and the constant is as given above.

This explanation assumes that the tensile strength of ice is not great enough to overcome the inertia of the ice at the time of the lowering of temperature which causes the cracks; and also, the rate of increase of temperature being the same as the rate of fall, the compressive strength of the ice will allow the expansion of the field.

Can the Editor supply any information as to the tensile strength of ice? The writer tested, last year, the compressive strength of some blocks taken from ice frozen from distilled water with the following results:

Cube 4 × 4 × 4 ins.....320 lbs. sq. in. contraction ¼ in.
2½ × 2½ × 4 ins. high..310 lbs. sq. in.
2½ × 2½ × 2¾ ins. high 320 lbs. sq. in. contraction ¾ in.

The blocks were free from cracks.

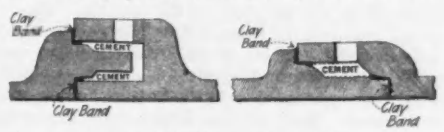
Yours respectfully, W. K. H.

Lafayette, Ind., March 18, 1894.

(According to German experiments described in Engineering News of Dec. 26, 1885, the tensile strength of ice is from 142 to 223 lbs. per sq. in.—Ed.)

AN ENGLISH SEWER-PIPE JOINT.

We illustrate herewith a joint for sewer pipe which has come into considerable use in England. Both single and double-socket joints are made, cement being poured in to complete the joint in



An English Sewer-Pipe Joint.

either case, after using bands of fireclay, as shown in the sections. Two holes are left in the hub of the pipe, one for pouring in the cement and another for the escape of air. The claim for these joints is water-tightness, coupled with increased strength to resist strains due to unequal settlement in the case of the double joint. The joints are controlled by the Archer Pipe Co., Limited, 19 Great George St., Westminster, London, S. W., manufacturers of sewer pipe, electrical and other conduits. The joint has been used and we are informed has given good satisfaction, in Southgate, Dartford and Chiswick, in London, and 12 miles of sewers in Cheadle, near Manchester, were laid with it.

* See Eng. News, Jan. 12, 1893, for an account of Mr. Dumble's experiments.

NOTES BY RAIL.

Pennsylvania R. R.—There are probably no better built or more comfortable passenger coaches than the standard day cars of this line. They accommodate 60 passengers, and have a closet and two stoves, while the fourth corner has a window seat. The interior finish is of oak, with very little molding or carving, and the headlining is of pinkish brown burlap studded with dull bronze headed nails. The seats are upholstered in crimson plush and there is a carpet in the aisle. The monitor roof is wide and shallow, and has five Frost lamps, while oil lamps are fitted in side brackets. The light colors and the ample window space give a notably light and cheerful interior effect, but a weak point is the small number and size of the bronze brackets for hand baggage. The cars are carried on four-wheel trucks. The four platform steps are made of sufficient depth to bring the lower step within reasonable distance of the ground, while the four steps of Pullman cars are frequently so short as to be high above the ground and awkward to climb.

The principal feature of interest on the New York Division is the introduction of the automatic electro-pneumatic block system, with overlapping blocks. On some parts of the division the system has been in operation for several months, and the old block signals have been removed and the towers boarded up. The main track signals are carried on overhead bridges spanning the four tracks, so as to admit of placing each signal over the center of the track it governs. At some of the yards the ground signals have large lamps with lenses of unusual size. There are four tracks all the way from New York to Philadelphia, except at drawbridges, laid with heavy rails spliced principally with six-bolt angle bars. Stone ballast is used throughout. The trestle which carries the newly elevated tracks through Elizabeth, to avoid the old grade crossing of the Central Railroad of New Jersey, is being rapidly filled in for a solid bank. Hedge fences were introduced on parts of this division some years ago, following English practice, but they do no seem to thrive, being thin and weakly, and in no way resembling the thick dense hedges characteristic of English railways. In the new Broad St. terminal station at Philadelphia, the rails rest on 2-in. wooden blocks (19 to a rail length) placed on longitudinal timbers which in turn rest upon crossties. There are 11 ties to a rail length, with a tie under each joint, but there is no blocking under the rail joints. The stone ballast is level with the tops of these ties.

The Philadelphia, Wilmington & Baltimore Division has a double track with stone and gravel ballast, and is laid with 85-lb. rails spliced by six-bolt angle bars, with the nuts inside. Additional block signals are being erected on this division. Post and rail fencing is used, and many of the road crossings are unprotected by cattleguards. Bridges are fitted with outside wooden guard rails, and sometimes also with inside iron guard rails. Near each bridge is a post painted black with the number of the structure in white upon it. The figures are of malleable iron raised ¼ in., so that an ordinary track laborer can renew them and keep up the painting.

The Baltimore & Potomac Division is also double track, laid with 85-lb. rails and six-bolt angle bars, the smooth riding over which is very noticeable as compared with the sections on which lighter rails are in use. The track is ballasted with gravel of rather small size and there are 14 ties to a rail length, the ties being very wide, which is a noticeable feature of the Pennsylvania R. R. track. A large part of the line is unfenced. This division is operated on the block system with the ordinary manual levers and signals. The compensators consist of two grooved pulleys, one above the other.

with a chain making a half turn round each, the signal wires being attached to the ends of the chain. The mile posts are square, painted white, with black raised figures of malleable iron. The whistle and ring posts are flat, painted blue on the running side, with white letters. Bridges are fitted with outside wooden guard rails, and some have iron inside guard rails also. At Baltimore the centering is up for a large stone arch street bridge being constructed by the city, and having long span arches crossing the Baltimore yards at a considerable skew. Through almost the entire center part of the city the railway is in deep cut or tunnel. South of Washington the line is single track, extending to Quantico, where connection is made with the Richmond, Fredericksburg & Potomac R. R. for through traffic to southern points. It crosses the Potomac by the Long Bridge, an arched Howe truss structure with a railway track and roadway. The rails are laid on longitudinal timbers across the bridge with suspended broken joints spliced by four-bolt angle bars, and there are 16 ties to a rail. The ballast is gravel. Piling has been driven at the toes of the slopes of some of the cuts to check sliding. Split switches are used, with double targets, but the Pennsylvania R. R. does not use guard rails in front of any switches on its line. Bridges have outside guard rails and sometimes have guards for rerails. Drawspans are protected by a semaphore signal in each direction. Longitudinal timbers carry the rails on one bridge. A railway crossing is being equipped with interlocking plant, but one of the derails is set close to a bridge portal. Pit cattleguards are used, and the road crossing signs are black oval boards with white lettering.

Richmond, Fredericksburg & Potomac Ry.—The track is laid with 56 and 67-lb. rails on white oak ties in gravel ballast. These ties cost 40 cts. each and have an average life of eight years. The rails are laid with broken suspended joints spliced partly by four-bolt and partly by six-bolt angle bars. At intervals two spare rails are placed, being carried in notches in two posts about 5 ft. high. The line is single track and the switch targets show a white disk for the main track and a red and white arm, like a semaphore blade, for the side track. Where the targets cannot be seen from a distance, owing to curves in cuts, etc., a yellow and black fishtail semaphore, interlocked with the switch, is placed at a minimum distance of 1,200 ft. from the switch, or as much farther as necessary, in some cases 1,800 ft. The split switches have short guard rails close in front of the switch rails. On bridges there are outside wooden guard rails, Latimer rerailing guards, and inside iron guard rails, the latter being extended well onto the approaches and brought to a point between the track rails.

Chesapeake & Ohio Ry.—This is a very important system and its importance and traffic are increasing with the growth of the ports of Newport News and Norfolk, while the Chicago & Northwestern Ry. is intending to make a grain route to the seaboard over the Cleveland, Cincinnati, Chicago & St. Louis Ry. and the Chesapeake & Ohio Ry., as there is a very large elevator and grain-loading pier at Newport News. Some notes on the main line from Washington, D. C., to Cincinnati, O., were given in our issue of Aug. 17, 1893. The line from Richmond to Newport News, 75 miles, is single track, laid principally with 75-lb. rails having broken supported joints spliced by six-bolt angle bars, and having 17 or 18 ties to a rail length, laid in broken stone ballast. Some of the sections have lighter rails and a rather bad riding track, but the early spring is hardly the time to expect the smoothest track, and on most of these sections new oak ties have been distributed ready for putting in the track. Split switches and spring rail frogs are used, and high switch stands with double targets. At each mile post is a spare rail placed on short stakes. The mile posts are of square section, set diagonally to the track, and painted white. The whistle posts are flat and the section posts are similar but smaller. Clearance posts are low and a large post marks the center of the side track. The road crossing signs are small and of X-shape. Some of the pit cattleguards are open, others are covered with beveled ties, and metal surface cattleguards are also used. Oval "one-mile" signs are placed in each direction from stations. There are a number of low trestles through swampy ground and these have outside wooden guard rails, as have open culverts. Water barrels are placed at frequent intervals along the trestles. Bridges have outside wooden guard rails and inside iron guard rails, the latter extended into the approaches and brought together. The company runs its own parlor cars, which are vestibuled, and are very handsome and comfortable, being fitted with reclining chairs. These cars are built by the Barney & Smith Mfg. Co., of Dayton, O. The locomotives and car shops at Richmond are not now very busy, but some engines are being rebuilt, and a number of 30-ton double side-dump ballast cars have been built at these shops. The stations at Richmond and Newport News are head-house terminals. The roadbed, structures, stations and rolling stock are well kept and in neat condition. The Eastern terminal is at Fortress Monroe, but the principal freight terminal is at Newport News, nine miles west of that place, where there are ore and coal piers, a grain-loading pier, elevator, shipping piers, etc. From this point the railway has a steam ferry to Norfolk, one hour distant, and freight terminals are also to be established at Norfolk.

Norfolk, Albemarle & Atlantic R. R.—This little 18-mile road from Norfolk, Va., to Virginia Beach, was built in 1882, when the standard gage had not been adopted by the roads entering Norfolk, and a gage of 3 ft. was adopted as being cheaper than the 5-ft. gage of the Norfolk & Western R. R. It is intended to widen the gage as soon as the necessary funds can be obtained, and on about three-fourths of the length of the line the old ties have already been replaced with 8½-ft. ties, while renewals with these ties are still in progress. The rails are of steel, 30 lbs. per yd., laid with broken supported joints spliced by four-bolt fish plates. There are 16 ties to a rail length and the ballast is principally dirt, but the roadbed is well drained by deep ditches. At the present time the line is being surfaced, sags raised and ditches cleaned, and one trestle is being replaced by a bank with three lines of vitrified culvert pipe. A steel drawbridge has just been completed across the Eastern branch of the Elizabeth River, and a plate girder span over Malones canal, in Norfolk, both replacing wooden drawbridges. A new plate girder turntable is also being erected. On sections where long and short ties are intermixed the riding is pretty rough, as might be expected, aggravated at this season by heavy rains. Pit cattleguards are used. Eight-wheel engines are used, built by the Baldwin Locomotive Works and the Virginia Iron Works, and the cars were built by the Brill Car Co. and Billmeyer & Small. The ordinary passenger cars have seats for two persons on each side of the aisle as in standard gage cars, and there are also twelve open cars for summer excursion traffic, having 16 transverse seats and carrying 80 persons each. The company intends to build a standard gage branch to Currituck Sound, in North Carolina, 25 miles south, and will also carry out improvements at Virginia Beach, where it owns the Princess Anne Hotel and 1,600 acres of land with 4½ miles ocean frontage.

Richmond Locomotive Works.—These works have undertaken the rebuilding of several engines for the Peoria & Eastern R. R. and the Cleveland, Cincinnati, Chicago & St. Louis Ry., and have also under construction three new ten-wheel engines for the Richmond & Danville Ry., and 20 engines for the Atchison, Topeka & Santa Fe Ry., so that the works are running full time, and all night in some of the shops, with a full complement of 950 men. The shops are well arranged, and as the carpenter shop at the end of the machine shop is getting cramped for room, a new one will probably be built, and the whole of the present building used as a machine shop. The pattern shop is especially light. The erecting shop has a Yale & Towne overhead crane. Most of the large tools are from Bement & Miles, of Philadelphia, and include slotters for slotting the frames of two engines at once, and large milling machines for finishing rods, cutting out rods of I-section, dressing the ends of rods, etc. Links and other parts are made rapidly and cheaply by a heavy drop hammer. Compressed air for pneumatic drills and hoists is supplied by a Boyden brake pump. There are four Tanner & Delaney boilers, and six engines, one for the machine shop, one each for the foundry, smith shop, boiler shop and pattern shop, and one for the electric light plant. Fire protection is provided by a water tank, automatic sprinklers and a fire pump, and hose houses are placed at different points. Among the interesting points noted were solid phosphor-bronze driving boxes, weighing 375 lbs. each. The cylinder castings are notably clean and well finished, and it is stated that Virginia iron is mainly used in the foundry. Radial stay fireboxes are now generally called for by purchasers. Tender frames are built of wood or channel iron, and it was noted that the cabs and tenders of the C., C., C. & St. L. Ry. were painted a dark Brunswick green instead of the usual black. These works have built two two-cylinder compound engines of the ten-wheel type, one of which has been in service for some months on the Chesapeake & Ohio Ry., while the other was built for the C., C., C. & St. L. Ry., and, except for the compounding arrangements, it is of exactly the same construction as 59 other engines ordered at the same time. The performance sheets show a decided economy in favor of the compound, and it has shown itself able to haul heavier trains than the simple engines. In a later issue we shall publish a description of this engine. Besides locomotives these works have built the engines for the battleship "Texas," which is now being finished at the Portsmouth navy yard. Mr. W. R. Trigg, is President of the company; Mr. E. F. C. Davis, General Manager; and Mr. C. A. Delaney, Superintendent.

THE PEORIA STAND-PIPE FAILURE.

A large stand-pipe at Peoria, Ill., failed on March 30, killing one person, injuring a large number and damaging several buildings. The structure was one of the two stand-pipes of the Peoria Water Co., described and illustrated in Engineering News of July 14, 1892. The following account of the failure, together with the specifications under which the pipe was built, was sent by Mr. Chester B. Davis, M. Am. Soc. C. E., of Chicago, engineer for the works, and by Mr. Dabney H. Maury, Jr., of Peoria. Further special reports of the accident, with illustrations, will be given next week:

The ordinance under which the Peoria Water Co. built its works required that there must be a storage reservoir and two water towers, of a combined capacity of 20,000,000 gallons. Their flow line is at elevation 320 city datum, or about 220 ft. above the general level at the court house. The towers were built on the top of the long bluff, which runs about due east and west, nearly parallel, and about a mile back from the river, and in somewhat open parts of otherwise thickly built-up districts. The pipe at the upper end or on the east bluff being on higher ground was made 30 ft. in diameter by 85 ft. high, and the other, or the west bluff, was 25×120 ft.

The plans and specifications for the entire works were prepared by Mr. Chester B. Davis, M. Am. Soc. C. E. The work of construction was placed in charge of Mr. E. H. Burlingame, C. E., who was made the president of the company. The reservoir and stand-pipe construction was in the direct charge of Mr. Eugene Carroll, C. E. The towers were built by the Porter Mfg. Co., Syracuse, N. Y., and were completed and put into use about May 1, 1890. They were tight and apparently all right, and never gave any trouble or cause for uneasiness until on Friday, March 30, at about 10:20 a. m., the one on the west bluff, from some cause not yet determined, burst with a succession of pistol-like reports, wrecking it completely and doing some, but not serious, damage, to buildings in the vicinity. One boy was killed, being crushed under the bent edge of falling sheets; and 15 more people were more or less injured by being tossed about by the escaping waters.

The tower contained about 400,000 gallons, the reservoir being somewhat below its natural level on that day, so that the water was not over 105 ft. deep in the tower, causing a pressure at its base of from 46 to 47 lbs.

The day of the failure was warm and pleasant and the wind was blowing from the west at a rate of probably not over six or eight miles per hour.*

*See statement in Professor Pence's report below.—Ed.

The weather had been mild for two or three weeks and no ice existed in the tower.

There had been a slight leak at the top of the seventh course, 35 ft. from the base, on the northwest side of the tower, and workmen had been sent to examine it, to make it tight if necessary, and to paint the discolored portions of the tower. It was found to be rusted up and tight, so no calking was done. The man painting it had reached the ground but a moment before the break occurred. As this joint and the plates around it are all intact and unbroken, it is evident that the fault was not at that point.

The water was supplied to the tower from the avenue west of it, through a 16-in. cast iron main, entering the tower through its bottom plate.

A manhole was at the east side of the tower in the lowest, or first course, and it remains intact in the sheet, save that the bottom of the sheet is torn away through a few of its rivet holes, thus breaking off a portion of the bottom of the flange. The sheets built 5-ft. courses, six sheets to the course. About one-third of the sheet only remained attached to the casting, and it, with a portion of the second, third, fourth and fifth courses, lie about 30 ft. southeast.

A careful study of relative positions of the pieces, as they now lie, of the condition and position of the holding-down bolts, the effects of the water and other facts bearing upon it, show that the rupture began on the north side of the tower, at or near a seam between the first and second courses, and its joint between two second course plates, and from there it tore upward to the right and to the left.

Some pieces, say one-fourth the arc, at the immediate left, or easterly side, were thrown varying distances to the street and yards beyond in a north-northeasterly course beyond them. At the right or westerly side, a piece, three courses high, 15×40 ft. long, or more than half the circumference, was torn off down to the bottom rim of angle irons, was straightened out, lifted up about 12 ft. and thrown against the cottage 100 ft. distant, and a little to the west of south. The remaining quarter, containing manhole and with some part of the fourth, fifth and sixth courses, was thrown 50 ft. east of southeast, with the upper course plates bent down on the top of those of the lower course.

Practically all of the tower above the sixth course was turned quarter way round and fell almost due east, the joint between the seventh and eighth courses being about 16 ft. from the base of the tower. The joint between the eighth and ninth courses was torn partly through the rivet holes for two-thirds of the circumference and was stretched out to the northwest, and the end was due north from the base and 14 ft. away from it.

As the tower fell the ladder is at the top near the east side and pointing directly at its former position. The tower in falling was flattened to about 6 ft. and was broken most at the top from the fall.

Within the last month observations made on the tower showed that it was truly vertical. The tower was built in level courses, with the lesser diameter downward.

A large portion of the fourth, fifth and sixth courses, say, 15×20 ft., was blown west across the arc, cutting off cleanly a tree, 9 ins. through, near the butt. A piece weighing several hundred pounds was thrown 250 ft. southwest, and small pieces spread from west to northeast; the remainder, a piece 15×15 ft., being dropped 75 ft. northeast, cutting off near the bottom a tree 7 or 8 ins. in diameter.

The following is an extract from the specifications, including everything which refers to the construction of the tower and the metal to be used in it:

The metal of the plates must be of a soft, homogeneous steel, unless otherwise specified, possessing a maximum tensile strength of 66,000 lbs. and minimum tensile strength of 55,000 lbs. per sq. in., and be officially and legally stamped; must be smooth, truly and evenly rolled and uniform in size, and sufficiently ductile to admit of rolling while cold around a radius of 20 ins., without developing flaws, cracks, splits, or any other features which would render them unfit for the work in the opinion of the engineer. The plates will be inspected by the engineer, upon notification before being put into the pipe and before painting, and all improper plates will be rejected.

Where iron plates are specified the iron must be best quality tank iron, having a tensile strength of 48,000 lbs. per sq. in. Test pieces of the plate will be made and broken by the contractor in the presence of the engineer when he may desire, and at no extra expense to the purchaser. The plates will be of such width that each course will build practically 5 ft. Each sheet will be not less than 12 ft. in length. Burden's "best-best" rivets must be used for the whole work. All horizontal joints will be single riveted, and the vertical joints will be double riveted, unless otherwise specified. The diameters and pitch of rivets must be satisfactory to the engineer.

The manhole, plate, rings, etc., inlet pipes and flanges, and all other cast iron work, will be of good quality, of fine gray pig iron, and must be sound, strong, smooth and perfect castings, and properly coated.

The bottom plate will be of ½-in. wrought iron with ½-in. cover plates and butt joints, double riveted with ⅝-in. rivets, and double riveted to angle rings as shown, which in turn will be double riveted to the bottom course, ⅞-in. rivets being used.

The flanges of the inlet and blow-off pipes will be bolted to the bottom plates, using lead or corrugated copper gaskets at all flange joints. The joints must be left water-tight. The bottom plates must be set in cement, mortar or grouting (one part Rosendale or equivalent cement, and three parts sharp, clean, fine sand), and so that no void will exist beneath it, or in a mixture of asphaltum and bitumen, as desired and directed by the engineer. The bottom plate must be truly level and the first course plates truly vertical when set in place.

The stand-pipes must be of the dimensions specified at the least inside diameter. The bottom course will be an outside course, and those above will be alternately inside and outside courses, or bevel courses upon approval. A suitable oval manhole 15 × 18 ins., or acceptable equivalent complete, and wrought iron lugs for holding down bolts, will be properly riveted to the stand-pipe as above. Twelve holding-down bolts of best refined iron, provided with washers, plates, alcove-nuts, lugs and steel pins, etc., and reaching to the bottom of the foundation will be furnished as shown on drawing for each stand-pipe.

Lay all holes out carefully and accurately and punch with a center punch, sharp and in perfect order, from the surface to be in contact and so that the bevel of the hole may be away from the surface in contact.

Plates showing any indication of hardness or brittleness, may be annealed after punching, or rejected at the option of the engineer. Plates having ragged holes or holes so much out of place as to require the use of the draft-pin will be rejected. All plates must be planed to a slight bevel in a machine, and be carefully calked with a round-nosed tool and made perfectly tight. Lay all the work out so that each joint will come halfway between those of the next course. Where three plates join, the overlap is to be neatly scarfed down while hot. Heat rivets uniformly and carefully and never set one when colder than red-hot. The riveting must be done in a neat and workmanlike manner.

The following schedule gives thickness and data for riveting the 25 × 120-ft. pipe (the one that failed).

Steel Plates.

Courses.	Thickness, inches.	Riveting.
Bottom	⅝	Triple.
2	¾	"
3, 4	1 1-16	"
5, 6	⅞	Double.
7, 8	9-16	"
9, 10	½	"
11, 12	7-16	"
13, 14	⅜	"
15, 16	5-16	"
17, 18	¼	"

Iron Plates.

19 to 24, inclusive	¼	Double.

Provide and construct balcony and crestings as shown by detail drawings of iron.

A ladder 15 ins. wide, of ¾-in. round iron rungs, shaped as shown, will be riveted by suitable brackets, or braces, not more than 10 ft. apart, to each stand-pipe. The steps will be 12 ins. apart, and begin 9 ft. above the water table. They will project 6 ins., except when drawn differently. The side bars of ladder will be ½ × 2¼ ins.

After inspection, which will be at the shop, each sheet must be cleaned and painted with, or dipped into a bath of hot asphaltum, and before being placed in the stand-pipe. There must be no paint on surface in contact. After testing, the work will be given two coats asphaltum or lead in oil, to suit the engineer. Paint all other iron work three coats. Paint all wood two coats.

The stand-pipe will be tested before receiving the final coats of asphaltum, by being filled with water and by being allowed to remain full for such time as the engineer may deem necessary to satisfy himself that the work is water-tight.

Since the above was put in type we have received from Prof. Wm. D. Pence, author of the monograph on "Stand-Pipe Failures and Accidents," publication of which is begun in this issue, the following special report on the causes of the failure:

In compliance with your request of March 31, I beg to submit the following statement relative to the failure of the 25×120-ft. stand-pipe at Peoria, Ill., on March 30. A careful survey of the premises has been made by Mr. J. A. Harmon, City Engineer of Peoria, and as he proposes to immediately furnish to Engineering News a full description of the wrecked structure, these remarks will be mainly confined to a discussion of the conditions existing at the time of the accident and of the cause of the failure.

At the time of its failure, 10:30 a. m., March 30, a strong west wind, almost equal to a gale, was blowing, its velocity, according to a statement of a credible authority, having been about 30 miles per hour. The stand-pipe had been leaking near the base for two weeks or more preceding, and when the accident occurred, four men were engaged in stopping the leaks. The wind grew in force and considerable difficulty was being experienced in holding the ladders for the use of the calkers against the sides of the stand-pipe, when a series of sharp reports resembling pistol shots were heard, followed instantly by the total demolishment of the lower fourth of the stand-pipe and the falling of the upper three-fourths to the leeward, the latter section flattening out by the force of the fall. As there was about 110 ft. of water in the stand-pipe at the time, the energy of the escaping water was enormous, resulting in extensive damage to surrounding private property. About fifteen persons were more or less injured and one was killed outright.

The upper section seems to have been rotated about its axis through an angle of 90° before striking the ground, the cause of which seems to have been due to the fact that the anchor bolts held fast considerably longer (i. e., in a relative sense) on one side than on the other. Although large sections of the lower six courses of plates were projected in various directions—notably a frgment of several tons weight which demolished a residence some distance to the southward—more heavy pieces seem to have been carried and deposited to the eastward or, perhaps, southeastward, than in any other direction, and the almost entire absence of pieces of large size toward the northwest was to be noticed. The foundation and anchorage seemed to be of first-class quality.

With a view to throw as much light as possible upon the subject, the writer advances the following observations reached through a careful study of the phenomena which usually accompany the failure of relatively tall stand-pipes under simple hydrostatic pressure:

(1) Initial rupture, of course, usually takes place near the base.

(2) The bed-plate is left undisturbed as to position, although indentures and incisions are frequently made in it by the edges of falling plates.

(3) A section of the stand-pipe, consisting usually of about the lower third, actually bursts, the bulk of the fragments of plates being projected in a direction diametrically away from the point of first failure, although individual fragments are frequently thrown or carried by the water in various other directions—more, however, as a rule, toward the side of first rupture.

(4) When undisturbed by wind or other exterior influence, the unruptured top section, consisting usually of more than the upper half of the structure, topples toward the point of first rupture.

Now, in general, the third and fourth observations above stated furnish a thoroughly reliable criterion for use in locating the point of initial rupture. Applying the third general observation to the Peoria failure, the conclusion is at once reached that the initial rupture took place on the west or northwest side of the stand-pipe, but considering the fourth, it seems extremely probable that the gravity tendency therein referred to was nullified, or at least sensibly modified, by the force of the wind. Considering all facts at hand, the

writer is led to believe that the initial rupture actually occurred approximately on the windward side and that the force of the wind was sufficient to cause the upper portion to topple to the westward and thus prevent its fall in the direction of the point of first rupture.

This leads to the question of cause. Considerable evidence has been given in the coroner's proceedings by alleged expert local boiler-makers to the effect that the steel plates used in the construction of the stand-pipe were defective in quality. Samples of the metal have been placed in the hands of a competent authority for analysis and structural test, but no facts have as yet been secured relative to the quality of the plate metal as shown by actual test. No claim that the usual structural tests of actual sample pieces from the plates were made during the manufacture of the stand-pipe has reached the notice of the writer, and after an examination of the ruins he feels warranted in believing that if the usual tests for elastic limit, ultimate tensile resistance, and elongation and reduction were actually made, the certificates of same certainly cannot be introduced as favorable testimony. Perhaps the most conspicuous feature developed by even a hurried examination is the existence of a large number of cracks of varying extent in the wrecked plates, and these cracks are especially significant in that they may be found in large numbers radiating from the edges of the rivet holes which seem to have been punched and not reamed. Although the riveting seems to have been done with care in the main, several lines of plate fractures along rivet rows show holes imperfectly filled by rivets. As the writer now recollects no such cracks appear in the six upper courses of ¼-in. wrought iron, but he believes the same is also true of the thinnest steel courses, so that a comparison of the two metals in the thin plates only is not conclusive. A long horizontal tear in the wrought iron plate, produced in the impact of falling, distinctly shows the fibrous nature of that metal.

Although ice has undoubtedly formed in the stand-pipe during the past winter, it must have melted previous to the failure, since none was found in the ruins. It has been suggested that the failure was due "in some unknown manner," to the formation of ice during the past winter, but as yet no theory as to the precise manner in which the ice might have brought about the failure has been advanced. The practically complete melting of the ice must have taken place during the prevailing warm weather early in March, for during the blizzard which occurred inside of a week preceding the failure, the temperature fell rapidly to a point below 10° F. That temperature was reached during two or three nights in succession, and it is stated that ice 1½ ins. thick formed on the night of March 24. Apparently the formation of ice to the extent just mentioned could not seriously affect the strength of a stand-pipe which had successfully withstood several winters of more or less severity. However, while believing that the ice formation within the structure in the usual manner to the extent stated above could scarcely have been a source of danger, the writer is prepared to believe that the leaks which had given external signs of their existence previous to the blizzard above mentioned, or, perhaps, other leaks not then fully developed), might have admitted water to some of the numerous spaces in rivet holes which have already been mentioned; and that the force developed by the freezing of such water spaces or pockets might have caused complete fracture to neighboring net plate sections in which lines of incipient fracture had been caused in the process of punching. This theory has been suggested to the writer by the excessive extent to which such minute lines of fracture were developed in the failure of the structure, and it seems scarcely necessary to refer to the Montreal "bomb-shell ice" experiments or to the various other familiar instances in nature of the expansive force of freezing water in proof of the sufficiency of this force to fracture plate metal when weakened as above stated. Since several of such individual fractures might have taken place without leading to immediate entire failure (particularly in the vertical lines of triple riveting near the base), it seems probable that the structure might have continued to stand in apparent safety through an indefinite period, but for the combination of causes which led to the failure at the time above mentioned. It is scarcely necessary to remark that the forces just described might have been acting at various times and that an oft-repeated strain might have accomplished a result perhaps improbable under a single application of the pressure.

Accepting the theory just stated, and believing that initial rupture occurred near the base on the windward side of the stand-pipe, it is the writer's opinion that a weakness existing there was developed to the point of rupture by the combined vibration due to the wind and the blows from the calkers' hammers, acting in conjunction with the hydrostatic pressure.

Among the numerous attempts to develop the underflow to furnish water for irrigation in the West may be mentioned a recent enterprise at or near Greeley, Colo., where a contract for a trench, 10½ ft. wide, 600 ft. long and 26 ft. deep, was let some time ago to Mr. Geo. W. Gale, of Greeley, by Mr. D. A. Canfield. At 12 ft. from the surface hardpan from 2 to 6 ft. thick was struck. This has been shattered by dynamite. After passing the hardpan, cribs and a dredge have been used. The dredge is of the clam shell type, with special features invented and patented by Mr. Gale. An arrangement of ropes and pulleys is employed in this dredge, designed to insure the closing of the shells or bucket before it begins to be lifted. The cost of this ditch is estimated at from $15,000 to $20,000. The water developed will be lifted to a ditch by means of a pump or pumps, made by Mr. J. B. Swan, of Denver, and will flow some five miles to a reservoir.

Tests recently made by Booth, Garrett & Blair, of Pittsburg, Pa., of the fineness of Saylor's Portland cement, showed the following results:

Sieve.			Per cent. of cement passed. Oct. 27, 1893.	Jan. 25, 1894.
No. 50;	meshes,	2,500 per sq. in.....	100.0	100.0
No. 74;	"	5,476 " "	99.0	99.3
No. 100;	"	10,000 " "	97.0	97.9
No. 200;	"	40,000 " "	73.5	72.0

The Cataract General Electric Co., a corporation connected with the Niagara Power Co., is now discussing the formal acceptance of a 50-year permit, obtained from Mr. Edward Hannan, of the State Department of Public Works, to put an electric plant along the lines of the New York state canals. The permit would authorize the company to enter upon all canal lands of the state for the purpose of erecting an electric plant for the towing of canal boats, but without interference with present methods of towing. The rates for towing are subject to review by the State Superintendent of Public Works, but must not exceed $20 per annum per E.HP. The company may also furnish electric light, heat and power at any points along the line, after the canal service is fully supplied; and must furnish the power, free to the state, for operating lock gates, and also electric light for illuminating the locks. The company must have its plant in operation between Buffalo and Albany within three years from date, or forfeit the permit. The president of the company is Mr. William Mertens, of New York, and Mr. Thos. C. Platt is also interested.

The Sutro tunnel litigation, commenced in 1889, has just been ended in favor of Adolph Sutro and his friends, by the decision of Judge Hawley, of the U. S. Circuit Court. In 1869, the Sutro Tunnel Co. was organized to build a mining, draining and exploring tunnel to the Comstock lode in Nevada. The capital stock was $20,000,000, and this was at once disposed of. In January, 1877, the tunnel company executed a mortgage to Hugh McCalmont and other Scottish capitalists, and this mortgage was increased until, in 1886, it amounted to $1,600,000, and steps were then taken to foreclose it. The McCalmonts finally agreed to take $800,000 for their interest in 1888; but the money could not be raised by an attempted assessment of shareholders. An extension of time was then granted, and finally $550,000 was raised from the stockholders and a syndicate provided the remaining $250,000, and the mortgage was purchased in the name of the Union Trust Co., of New York. About one-fifth of the stock remained outside of the Comstock Tunnel Co., then formed, and this contingent, in December, 1889, commenced suit and asked to have all the transactions set aside on the ground of fraud. The testimony covered 5,000 pages, and the briefs and pleadings 800 and 200 pages more. The Court now upholds every act of Adolph Sutro and finds for the defendant.

Petroleum has been discovered, in very considerable quantity, in the Grosnoje district of Russia, north of the Caucasus. A well 440 ft. deep is said to have produced in four days 3,280 tons of oil of good quality. This region is easily connected with Vladikaukas, the extreme southeastern terminus of the railway system of Russia. Vladikaukas is only 400 miles from Rostov, the seaport at the head of the Sea of Azov; while the older deposits of Baku are nearly 500 miles from Batoum, on the Black Sea, and have no rail communication with Russia. This discovery should tend to extend the field for Russian petroleum, especially in Russia itself, as existing railways will serve for distribution.

The New Jersey State Road Improvement Association is making an aggressive campaign to have the state road appropriations increased from $75,000 to $125,000. The practical operation of the existing road law is so satisfactory as to awaken a general demand for further state aid, though the system is yet in an experimental stage, and will not be in full working operation for a year or two yet. For the present year specifications for county boards of freeholders have been approved that will use up all of the $75,000 appropriated and applications are on file for aid in building 51 miles of road and others are coming. From the present outlook the state could profitably expend $200,000 this year in aiding counties to build permanent highways. The New Jersey road law is the most liberal of any in the United States, and that state seems to be in a fair way of successfully working out a very difficult public problem. A delegation of New York assemblymen is about inspecting the New Jersey roads with a view of introducing a bill providing for a similar system in New York.

The elevated moving sidewalk recently proposed for the Chicago downtown loops of all elevated railways has been dropped as a project, according to the papers of that city. The reason given is that the elevated railways can take care of themselves without this adjunct and decline to co-operate.

"Country Roads," the first of a series of illustrated primers on roadmaking, has been issued by the New York State Division of the League of American Wheelmen. A copy will be sent free to any county or town officer, civil engineer, highway commissioner or overseer in New York sending his name and address, and a copy will be sent to any other address on receipt of 5 cts. in stamps sent to Mr. Isaac B. Potter, Potter Building, New York, or to Dr. W. J. Packwood, 1280 Michigan St., Buffalo, N. Y. The primer tells in plain terms what bad dirt roads mean to the farmer and gives him pointers upon methods of improvement.

A test of 12-in. steel armor-piercing projectiles was commenced at Sandy Hook on March 20. The projectiles were of the Holtzer type, made by the Midvale Steel Co., of Nicetown, Pa., and the Carpenter, made by the company of that name at Reading, Pa. Each shot is about 3½ ft. long, weighs about 1,000 lbs. and is hollow for one-third of the length, with the head specially hardened. The test plate was a 13½-in. oil-tempered, annealed, nickel-steel plate, about 9x16 ft., bolted to 3 ft. of oak backing and reinforced by 38 ft. of sand. It was made at Bethlehem, Pa. At a range of 150 yds. a 12-in. rifle was loaded with 355½ lbs. of brown prismatic powder and a Carpenter shell. This shot landed on the upper left-hand corner of the plate; dislodged a piece of the plate and developed several radial cracks. The shot was dug out in three pieces; from the heat generated by impact a mass of sand was found fused to the point. The second trial was with a Holtzer shell of 995 lbs. It clearly pierced the plate below and to the right of the first shot, and greatly widened the cracks. The third shot, a Carpenter, demoralized the plate, showing several cracks clear across the plate and a large fissure across the lower part. The fourth and last shot was a Holtzer, which completely demolished the plate. When dug out the second Holtzer and the second Carpenter shots were found practically intact. The first Holtzer was not found.

The proposed reduction of $90,000 in the appropriation for the U. S. Coast Survey and Geodetic Survey in the pending "Sundry Civil Appropriation Bill" is opposed by the National Association of German-American Technologists. The executive committee of the association, representing societies in Boston, Buffalo, Chicago, Cincinnati, Cleveland, Lynn, Newark, New York, Philadelphia, Pittsburg, St. Louis, and Washington, adopted a resolution at its meeting on March 9 opposing the reduction in the appropriation and urging the Senate committee to restore the appropriation to the same amount as in former years.

The water power canal which the Minnesota Canal Co. proposes to construct from a point on the St. Louis River, twelve miles above Cloquet, to Duluth is to be put under construction this spring, according to reports. It is also stated that the contract for the

construction of the 33 miles of canal 40 ft. wide will be let May 1. The work will be in charge of Mr. W. E. Darwin as superintendent of construction. The estimated cost of the canal is $3,000,000.

Plans for a pneumatic tube system for distributing mail matter from the general post office at Clark and Adams Sts., in Chicago, to the twelve branch stations of the city have been prepared at the request of Postmaster Hesing. The distance to be covered by the tubes of the proposed system is 33.1 miles, and the cost is estimated at $986,151. According to the plans, steel tubing is to be used, with aluminum carriers; and duplicate plants for supplying the compressed air will be constructed. In this connection it may be noted that a pneumatic tube system for delivering telegraphic news from Western Union offices to the various Chicago newspaper offices has recently been completed and is now in successful operation. We hope to give full details of the construction of this system in an early issue.

A beamless brake in which the shoes are carried by rocker arms attached to the spring plank has been recently patented. The shoes for one wheel are below and those for the other wheel above the spring plank. C. F. Porter, of New Orleans, La., is the agent.

Scoria blocks are used for street pavements to a considerable extent in Montreal, and we believe in some other Canadian cities. They are made in England from blast furnace slag mixed with clay and molded into bricks. They are said to make a very hard and durable pavement.

Another Niagara power company is seeking a charter from the New York Legislature. This is the Niagara, Lockport & Ontario Power Co., with $10,000,000 capital. It is proposed to construct a hydraulic canal from the Niagara River, at Tonawanda, to the gorge at Lockport, and there convert the water power into electric power. The company also offers pure water and electric light and power to Lockport and other cities and towns. The incorporators are citizens of Lockport, N. Y.

Measures to prevent the spread of pulmonary tuberculosis are being taken by the State Board of Health of New York. A circular on the subject has been prepared and sent to every newspaper in the state and another circular has been suggested for distribution among consumptives and those living with them. The Board of Health states that the communicability of pulmonary tuberculosis is now generally recognized by the medical profession throughout the world, and that in a majority of cases the disease is not fatal and that it often may be cured. The disease germs are given off in the sputa of persons suffering with the disease, which should never be so deposited as to dry up and allow the germs to infect air breathed by any one. Mr. Lewis Balch, Albany, N. Y., is secretary of the New York State Board of Health.

The epidemic of typhoid fever at Buffalo, N. Y., noted editorially March 22, seems to have reached its height in a few days and then fallen off rapidly, but on March 20 there were reported 22 cases, against some half dozen per day at the beginning of the month, showing that the danger was not all over. Mr. Louis H. Knapp, Engineer of the Buffalo water-works, has given us a few notes regarding the location of the old and new intakes, substantially as follows: The old intake tunnel is 4 ft. in diameter and extends out under the canal and harbor, to the Niagara River, a distance of about 300 ft., the canal being about 100 and the harbor about 120 ft. wide. The least diameter of the new intake tunnel is 6 ft. It is 20 ft. down stream from the old and extends 700 ft. into the river from the old inlet, ending about 1,000 ft. from the Canadian shore. For nine months of the year both supplies are good and the new is always so. The supply from the old intake is affected by the discharge from the Buffalo River and for about three months in the year it is bad. When possible the supply has been drawn entirely from the new intake since its completion, but it sometimes happens that the new supply is partly shut off by low water and ice, at which times the old intake must be used. If water cannot be drawn from the old intake in the future another tunnel will have to be driven out to the new intake crib. Mr. Knapp inclosed a newspaper clipping with his letter in which a physician in Buffalo claims that there is no serious epidemic there, but during the first 20 days or so of March it is reported that there were nine deaths from typhoid fever, against four during the whole of March, 1893, and one during March, 1892. The few deaths during this epidemic would seem to indicate a mild form of the disease.

An international exhibition is to be held at Hobart, Tasmania, this year, commencing in November. Large exhibits are expected from Great Britain and other European countries, India, Canada, Cape Colony and all the Australian colonies. Tasmania is a very rich mining country, and has large agricultural districts and cattle stations. Agricultural implements and mining machinery are therefore in great demand, and there is a field for American enterprise in this direction. The agents of the exhibition in the United States are Woltmann, Keith & Co., of 11 Wall St., New York city.

Float observations made on the Great Lakes, by Professor Harrington, of the Weather Bureau, show four general currents in all the lakes. The outflow towards the outlet of the lakes, a continuous current affecting the entire mass of water and proceeding slowly, with perceptible reactionary flow, resulting in more or less of a circular current around the lake; a surface current due to the prevailing winds and consisting of a mass of water driven before the wind and including also a return or reactionary current caused by the flow into depths made vacant by the action of the winds; return currents, and, finally, surf motion. The most important current is the surface flow caused by the winds. It has long been known along the lakes that the wind will blow in the direction in which the current was running from two to flow caused by the winds. The general velocity of these lake currents is from four to twelve miles per day; though much difficulty was encountered in attempting to fix these rates.

The remarkably rapid growth of Brooklyn, N. Y., in the last 20 years, is made the subject of an article in the "Eagle" of that city, and from this the following figures are taken:

	1873.	1893.
Assessable value of real and personal property	$216,282,870	$506,054,676
Population	447,000	988,308
New buildings erected per year	972	3,427
	1883.	1893.
Travel over East River bridge	6,183,540	42,423,864
Travel over East River ferries	30,035,000	35,575,000
Total travel over East River	36,218,540	77,998,864

The International Railway Congress for 1895 will be held in London, as fixed upon at the St. Petersburg Congress of 1892. The first of these congresses was held in Brussels, in 1885; then followed Milan, 1887; Paris, 1889, and St. Petersburg, 1892. Practically all of the English railway companies will be represented at the London meeting, and the Prince of Wales will preside. Forty-seven governments now send representatives to these congresses, including Great Britain and her colonies, coming from 250 railway corporations, representing 120,000 miles of track. The papers submitted at the London meeting will all be in English or French. Membership is confined to the representatives of not less than 30 miles of railway, excluding tramway systems. The annual subscription is $20 plus 5 cts. for each mile of line open to traffic. Companies can send from two to eight delegates, according to length of line, and they are entitled to copies of the proceedings, reports and papers, one for each delegate sent, plus one. The secretary of the English section is Mr. W. M. Acworth, 29 Abingdon St., London, England.

The manual block system has been put in operation on the line of the Chicago, Milwaukee & St. Paul Ry. from Chicago to Council Bluffs, 487 miles, and is to be adopted also on the line from Chicago to St. Paul, 420 miles.

CONSTRUCTION NEWS.

(Readers are invited to contribute items concerning new construction of interest to engineers or contractors for insertion in these columns. Those using these pages for information are informed that announcements of calls for proposals are inserted but once, and are not repeated from week to week.)

RAILWAYS.

East of Chicago—Existing Roads.

BELLEFONTE CENTRAL.—J. B. Mitchell and W. J. Myers are members of a committee appointed at Pine Grove Mills, Pa., to secure an extension of this railway from State College to that place, 3½ miles.

BUFFALO & SUSQUEHANNA.—The contract for the extension from Galeton, Pa., east to Ansonia, 13½ miles, has been awarded to D. A. Craig, Buffalo, N. Y., and Frederick Crego, Bradford, Pa., according to reports, and it is stated that 700 men will soon be put at work.

CENTRAL NEW YORK & WESTERN.—Press reports state that the right of way has been secured for extending this railway nearer the heart of the city of Hornellsville, N. Y., and that a new passenger station and freight house will be erected there, both improvements to be completed this summer. Extensions of the road are also contemplated both north from Wayland and south from Angelica, but no definite action has yet been taken.

WASHINGTON & CHESAPEAKE BEACH.—Capt. A. H. Mattox, Gen. Man., is reported as stating that about 600 laborers and 300 mule teams are now at work on this railway, and that subcontracts on the entire road will be awarded this week. The 2,000-ft. pier is being completed at the rate of 100 ft. per day, and contracts have also been awarded for the grading of the Chesapeake Beach town site. The pier is expected to be completed about April 15, the telegraph line by May 15 and the railway and at least one wing of the smaller hotel by July 15. The main hotel will cost at least $1,000,000 and cannot be completed before next year. Coffin, Sullivan & Co., New York, are the general contractors for the railway and pier.

Projects and Surveys.

BALTIMORE NORTHERN.—The bill incorporating this company to build a railway from Baltimore to the Pennsylvania state line has been reported favorably by the house committee. Incorporators, Wm. Gilmore, M. H. Houseman, S. J. Poe and J. H. Miller. Engr., R. A. Cunningham, Baltimore.

NEW YORK.—The Albion correspondent of the Rochester "Union and Advertiser" states that Emmons, Dryer & Co., Syracuse, have offered to construct the proposed railway from Batavia to Oak Orchard Habor, by way of Albion, if $60,000 of stock is taken in that city, and that nearly all of this amount has already been taken.

WISCASSET & QUEBEC.—It is stated that contracts have been awarded for 3,500 tons of 35-lb. steel rails and for 175,000 ties for the construction of this projected railway. The road will be 2-ft. gauge and the main line, from Wiscasset to Burnham, 42 miles, will be constructed this summer. Engr., Warren Nickerson; Pres., Geo. H. Crosby, Albion, Me.; Contractor, Thos. A. Rowe, 209 Washington St., Boston.

Southern—Existing Roads.

BOSTON & ALBANY (GA.).—Press reports state that there is talk of completing this railway to Albany, Ga. The line now extends from Pidcock, on the Savannah, Florida & Western, to Moultrie. Supt., C. W. Pidcock, Pidcock, Ga.

MACON & ATLANTIC.—It is reported probable that the construction of this railway to Savannah, Ga., will soon be resumed. Address John R. Young, Savannah, Ga.

Northwest—Projects and Surveys.

CHICAGO, ST. LOUIS & CAIRO.—Incorporated in Illinois to construct a railway from Chicago to East St. Louis, and thence to Cairo, Ill.; capital stock, $9,000,000; principal office, Springfield, Ill.; directors, A. W. Cross, M. R. Locke and P. D. Cheney, Jerseyville, Ill.; G. A. Saunders, and G. E. Ayers, Springfield, Ill.; D. H. Donovan, Chicago, Ill.; C. F. Griffith, St. Louis. The road is expected to cost $20,000 per mile, according to press reports, and A. W. Cross is reported as stating that every cent of the $9,000,000 of capital stock is pledged. The road is projected to pass through the following counties: Alexander, Pulaski, Union, Johnson, Jackson, Williamson, Randolph, Perry, Greene, Morgan, Sangamon, Menard, Logan, De Witt, McLean, Monroe, Washington, St. Clair, Madison, Clinton, Bond, Jersey, Macoupin, Livingston, Grundy, Kankakee, Kendall, Will, Du Page and Cook.

Southwest—Projects and Surveys.

GALVESTON & GREAT NORTHERN.—Incorporated in Kansas to construct a railway 1,000 miles long from Niobrara, Neb., to Galveston, Tex.; capital stock, $18,000,000; principal office, Sterling, Kan.; directors, Edward Roemer, P. J. Doherty, E. J. Shafer, Frederick Emigholz, New York; D. F. Orourke, Altoona, Pa.; Jas. Galloway, Hoboken, N. J.; A. R. Clark, T. H. Brown, P. P. Trueheart, Sterling, Kan.

HIGHLAND & ST. JOSEPH.—It is stated that bids are being asked for the construction of this railway from Ryan's Station, on the St. Joseph & Grand Island road, to Highland, Kan., a distance of about 7 miles. J. C. Beeler, Highland, Kan., is interested.

SAN ANTONIO & GULF SHORE.—A press report from San Antonio, Tex., states that that city has failed to subscribe the required $100,000 necessary to secure the building of this railway to that city, and that William Davis, president, has left for Velasco to arrange for beginning the construction work at that end of the line. Velasco has subscribed $200,000 and donated depot grounds, etc., and agrees to bridge the Brazos River for the road, according to reports.

TEXAS.—It is reported at Canyon City, Randall county, that the projected railway from Washburn, Tex., across the plains, through Canyon City to Midland, on the Texas & Pacific, is now taking definite shape, and that the construction is expected to be commenced at an early day.

Rocky Mt. and Pacific—Existing Roads.

FLORENCE & CRIPPLE CREEK.—About 20 miles of track have been laid north of Florence, Colo., and passenger trains were to have been put on for that distance April 1. The track-laying is now completed through the eight-mile canyon and over all the truss bridges, and for the remaining distance the line is said to be comparatively straight and smooth. About 1,500 men are employed upon the grade about the Victor mine, and it is expected that the entire road will be completed in about a month.

ILWACO RY. & NAVIGATION.—The senate has passed the bill granting this company a right of way across the Scarboro Hill military reservation. Pres., L. A. Loomis, Ilwaco, Wash.

Projects and Surveys.

COLORADO.—The Pueblo "Opinion" states that men are at work compiling statistics for a proposed railway from that city to Durango, by way of Red Cliff, Hardscrabble Silver Cliff, San Luis Valley and Creede.

DENVER, COCHITI & ALBUQUERQUE.—Incorporated in Colorado, to build a railway from Alamosa, Conejos county, to Espanola, N. Mex.; capital stock, $150,000; Principal office, Denver; incorporators, W. R. Barbour, F. G. Moffat, R. W. Holmes, Arthur Knaebel, and Ralph W. Landon, Denver.

OGDEN & BRIGHAM CITY.—Incorporated in Utah to build a steam or electric railway from Hot Springs to Brigham City, a distance of about 15 miles; capital stock, $1,000; incorporators include Mark Fletcher, lessee of the Ogden & Hot Springs R. R.; Pres., Jas. P. Sprout; Vice-Pres., Ed. Reed; Treas., J. C. McCoy; Secy., Geo. F. Philips, all of Ogden.

Foreign.

GUADALAJARA TRAMWAY.—This company has contracted with C. H. M. Blake, Guadalajara, Mex., to construct a tramway line, to be operated either by steam or animal power, from the village of Atemejac to the suburban town of Zapopan, which is about 7 miles from Guadalajara. The line is to be completed by Aug. 1.

MEXICO.—A press report from Monterey, Mex., states as follows: A corps of civil engineers has been sent here from New York by C. P. Huntington, Pres. Southern Pacific Co., with instructions to run a survey of a route for a railway from this city to Monclova, at which station connection is made with the Mexican International, which is also a part of the Southern Pacific system. The Mexican International is now being extended to the Sierra Mojada mining camp from Monclova, and the proposed line to this city is to be built for the purpose of obtaining a direct outlet for the rich silver ores of Durango and Sierra Mojada. The building of the proposed road will give Monterey a much shorter standard gage route to the United States than at present. The work on the extension of the Monterey & Mexican Gulf R. R. from Trevino to Sierra Mojada will begin in a short time.

A press report from Linares, Mex., states as follows: A few years ago a syndicate of American capitalists obtained from the Mexican government a concession, together with a subsidy of $15,000 per mile, for a railway to extend from Matamoras, on the Rio Grande frontier, to this city, and thence to mining districts south of here and to Monterey and to other points in the western part of the republic. About 30 miles of the road were graded and the track laid, when work was suspended owing to some financial difficulty which the company met with. The concession has not been forfeited, and it is announced here that arrangements have just been made for the completion of the road. It will be one of the most extensive railway systems in Mexico.

STREET AND ELECTRIC RAILWAYS.

BRISTOL, N. H.—The incorporators of the Bristol Electric Ry. Co. have organized by electing R. W. Musgrove chairman and I. A. Chase secretary.

WARREN, N. H.—It is proposed to construct an electric railway from this village to the summit of Mount Moosilauke, about 10 miles, the power to be taken from the Baker River.

SOUTH HADLEY FALLS, MASS.—Surveys have been made for an electric railway to Plainville. Unless the road is built by the Holyoke St. Ry. Co., a new company will be formed to build it, according to reports.

NEW HAVEN, CONN.—The New Haven & Centerville R. R. Co. has petitioned for authority to adopt the trolley system, to lay double tracks and to make certain extensions.

ITHACA, N. Y.—The Cayuga Lake Electric Ry. Co. has been incorporated to construct a summer electric railway from Percyfield on the lake road, Ithaca, to the southeast corner of Cayuga Lake; capital stock, $25,000; directors, Alfred Hand, Horace E. Hand, E. L. Fuller, Scranton, Pa., and others.

NIAGARA FALLS, N. Y.—A press report states that Burt Van Horn, Jr., the chief projector of the Niagara Falls, Whirlpool & Northern Electric Ry., has left for New York to negotiate with several firms before letting the contract for the construction of the road, which is to be completed in May. When the road is built it is expected that traffic arrangements will be made with the Niagara Falls & Suspension Bridge St. Ry., making a through line from Schlosser dock to the Devil's Hole. If the latter company will not enter into negotiations to this end, the Niagara Falls, Whirlpool & Northern will endeavor to get a franchise to run east of the present street railway to Prospect Park.

POINT PLEASANT, N. J.—The South Jersey St. Ry. Co. has been incorporated by H. A. Mandeville, South Orange; J. R. Weeks, Newark; F. Brewer, West Orange, and others; capital stock, $200,000.

ADAMSTOWN, PA.—The directors of the Mohnsville & Adamstown Electric Ry. Co., incorporated March 6, are reported to have completed arrangements for the building of the proposed railway without issuing bonds. The farmers along the line have agreed to assist in the construction, and it is expected to have the line in operation in June. Pres., L. I. Custer.

HOUTZDALE, PA.—The Houtzdale & Suburban Electric Ry. Co. has been incorporated to construct an electric railway between this place and Osceola Mills, a distance of 15 miles; capital stock, $100,000; Pres., A. Markle, Hazleton, Pa.

ROCKFORD, ILL.—J. S. Ticknor, Pres. Rock River Electric Ry. Co., noted Feb. 22, is reported as stating that the construction of the road will soon be commenced. The route decided on is nearly an air line from Dixon to Grand Detour, crossing the river just above the lower ferry, following the stream to Oregon and thence to this city. The water-power plants at Dixon and Oregon, each of about 300-HP. capacity, will generate the electricity. Later it is planned to put in a dam at Grand Detour, where a fall of over 9 ft. can be secured, furnishing an abundance of power.

KIRKWOOD, MO.—This town has granted a liberal charter for 50 years to J. D. Houseman, Jr., Dr. John Pitman, G. W. Taussig, and others for the proposed electric railway from St. Louis to this place and Meramec Highlands. Mr. Houseman is reported to have secured a nearly air-line right of way about 9 miles long and 50 ft. wide and to have filed with the county recorder the largest number of deeds ever presented for record by one person or at any one time in the county. The route will be almost entirely over a private right of way and without a single right-angle curve. The fare between this place and Fourth St., St. Louis, will be 10 cts. The construction of the road is expected to be commenced within a few days.

ST. LOUIS, MO.—The plans and specifications of the Grand Ave. Ry. Co. have been approved, and E. H. Conrades, Secy., is reported as stating that work on the new road will be commenced within two months. The road will run from the Water Tower in North St. Louis to Carondelet.

DALLAS, TEX.—The Dallas Belt Line Ry. Co. has been incorporated by Wm. Shotka, A. T. Perkins, C. H. McDonald, and others; capital stock, $100,000.

NIAGARA FALLS, ONT.—At a meeting of the officers of the Niagara Falls Park & River Ry. Co., the Hon. Richard Harcourt, State Secretary, and the Queen Victoria Park Commissioners, held last week, it was decided to allow the railway company to lay a double track through the Park. It is also stated that the road will be extended up the river two miles above Chippawa. W. S. Grant, who has been superintendent of the road since its construction was begun, has tendered his resignation to take effect May 1. It is understood that his successor will be Ross Mackenzie.

ELEVATED RAILWAYS.

CHICAGO, ILL.—The extension of the Lake St. Elevated Ry. from 48th to 52d St. has been completed, and it is stated that the extension to Austin and Oak Park will now be pushed.——Plans are being considered, according to reports, for the proposed stock-yards extension of the Alley Elevated Ry.

HIGHWAYS.

OHIO.—Bids are asked until April 7 for improving Carthage Pike, and until April 14 for improving Paddock road, Mill Creek and Springfield townships, Hamilton county. Fred. Bader, Pres. Bd. County Comrs., Cincinnati.

BRIDGES AND TUNNELS.

UXBRIDGE, MASS.—There is talk of a special town meeting to consider the question of an iron bridge over the Blackstone River at Calumet village. The town has voted to build a wooden bridge, but an iron bridge would cost but $1,700 more.

ANNAPOLIS, MD.—The county commissioners have appointed Commissioners Baldwin and Phelps to consider the practicability of constructing a bridge at Pumphrey's Mills, fourth district.

CINCINNATI, O.—The commissioners of Hamilton county will receive bids until April 21 for the iron superstructure of a bridge over West Fork Creek, on Llewellyn St., Cincinnati and Mill Creek townships.

HAMILTON, O.—The state senate has passed a bill authorizing the commissioners of Butler county to issue $10,000 of bonds for a bridge across Gregory's Creek.

LEXINGTON, MO.—The Lexington Bridge & Terminal Co. has been organized by W. G. McCausland, J. C. McGree, Wm. Morrison, Leo Keller and others to secure the construction of the bridge noted last week.

COLUMBIA, TEX.—The contract for the proposed bridge has been awarded to the Chicago Bridge & Iron Co., at $24,757, as stated last week. G. P. N. Sadler, Consult. Engr., writes us that the bridge will have one 228-ft. draw span, one 95-ft. and one 60-ft. steel span, three stone piers, two steel piers, an 80-ft. approach, 1,000 cu. yds. fill, an 18-ft. roadway and will carry a load of 100 lbs. per sq. ft.

HOUSTON, TEX.—Bids are asked until April 30 for the construction of a bridge across Buffalo Bayou, at the foot of Factory St. John T. Browne, Mayor.

WESTON, ORE.—Press reports state that three bridges have been carried away by high water in this town and several others in the Walla Walla Valley. The streams have not been so high before in 15 years.

LOS ANGELES, CAL.—The council has adopted revised plans for the proposed Third St. tunnel; estimated cost, $140,000.

STRATFORD, ONT.—The "Beacon" states that the township of Downie is about to erect a steel bridge at the crossing known as Byer's bridge.

WATER-WORKS.

MECHANIC FALLS, ME.—J. H. De Coster, Tn. Clk., writes us that A. J. Weston, J. W. Penney and C. E. Stevens are members of a committee that is investigating the question of works. Estimates, prepared last year, place the cost of works at $63,000 to $78,000.

WISCASSET, ME.—The citizens are considering the question of works. Address E. T. Hodge.

GREAT FALLS, N. H.—The mayor has recommended that the question of works be considered.

NEW MARKET, N. H.—A meeting was held March 31 to consider the question of a supply for fire protection.

MANCHESTER, VT.—Joel Foster, Montpelier, has been engaged to report on the question of a supply.

ATTLEBORO, MASS.—The town has appropriated $32,000 for extending the water mains to the villages of Dodgeville and Hebronville.

BLACKSTONE, MASS.—Willard Kent, Engr., writes us that the petition for a charter for the Blackstone Water Co. has not yet been granted and that the details for the proposed works have not been decided upon.

HUDSON, MASS.—The special committee has reported in favor of a second pipe line from the reservoir at Gates' Pond, Berlin, 2½ miles in length; estimated cost, $27,000.

LAWRENCE, MASS.—The contract for special casting has been awarded to the Davis Iron Foundry. The bids for lead service pipe were as follows: Boston Lead Co., $1,595; National Lead Co., $1,580; Treat Hardware Co., $1,557; F. W. Kidd, $1,538; M. E. Austin & Co., $1,512; Riley Bros., $1,507; C. F. Lynch, $1,502 (awarded contract).

MEDFORD, MASS.—The board has voted to ask for bids for a supply of pipe. E. W. Hayes, Clk.

SAUGUS, MASS.—The town has appointed a committee to consider means for securing a better supply from Lynn; also voted a water loan of $10,000.

WORCESTER, MASS.—The committee has recommended extensions in six streets, and that 4,039 ft. of cement-lined pipe be taken up in Kendall St. and 16-in. iron pipe laid.

BROOKLYN, N. Y.—Bids are asked until April 18 for furnishing a daily supply of 500,000 gallons on the Kings County Farm, Kings Park. Bernard Lamb, Secy., 29 Elm St.

DOLGEVILLE, N. Y.—Bids will soon be asked for constructing proposed works, according to reports. W. H. Bacon, Secy.

ALTOONA, PA.—Harvey Linton, Cy. Engr., writes us that the contract for an impounding reservoir at Kittanning Point has been awarded to Collins & Martin, at $156,503, the capacity of the reservoir not to be less than 300,000,000 gallons.

GETTYSBURG, PA.—Chas. M. McCurdy, Pres. Gettysburg Water Co., writes us that W. H. Dechant, of Reading, is the engineer of the proposed improvements.

GLENFIELD, PA.—The Neville Island Water Co. has been incorporated to supply water to Neville township; capital stock, $5,000; Treas., E. C. Kleinman.

PITTSBURG, PA.—Local papers state that the contracts for supplies have been awarded as follows: Red lead, Pennsylvania Lead Co.; gate boxes, Jas. B. Hill; machine work, W. S. Brown and McGill, Wilcox & Co.; miscellaneous castings, Union Foundry & Machine Co.; brass ferrules, Wadsworth, Evans & Co.; fire hydrants and valves, Ludlow Valve Mfg. Co.; special castings, Fisher Foundry & Machine Co.; electric lamps, Henry Grier & Co.; carbons, Brush Electric Co.; hemp, etc., H. L. Childs & Co.; hauling water pipe, William Gew; repairing pump at Herron Hill, Wilson, Snyder & Co.

CUMBERLAND, MD.—Bids are asked until April 10 for furnishing and laying 1,500 ft. 12-in., 5,000 ft. 10-in., and 6,000 ft. each of 8 and 6-in. pipe. W. L. Griffith, Secy. Comrs.

GAFFNEY, S. C.—The question of work is being discussed.

GEORGETOWN, S. C.—There is talk of putting in works, according to reports.

NEWBURY, S. C.—Col. J. W. Baum, Atlanta, has recommended a supply from artesian wells; estimated cost of works, $25,000.

AUGUSTA, GA.—There is talk of new works, which the mayor estimates can be put in for $120,000 to $150,000.

COLUMBUS, GA.—A committee has been appointed to confer with the water company for a supply for the northern extensions of the city.

HUMBOLDT, TENN.—A proposition is being considered for works and an electric light plant, according to reports.

DANVILLE, KY.—Henry E. Woolfolk, Chn. Com., writes us an election will be held April 14 to vote on an issue of $70,000 in bonds for works; supply from Dix River; population, 4,000.

MANTON, MICH.—Bids are asked until April 10 for constructing works. H. G. Hutzler, Vil. Clk.

PONTIAC, MICH.—H. G. Monroe, Supt., writes us that the question of issuing $15,000 in bonds for extensions will be voted upon at the spring election. The work will be done under the direction of the superintendent.

AURORA, ILL.—The council has voted in favor of an appropriation of $45,000 for extensions.

CHICAGO, ILL.—The Chicago Heights Water, Light & Power Co. has been incorporated by H. L. Wallace, Homer Abbott, M. H. Kilgallen and the Jos. Stockton Co.; capital stock, $100,000.

DUNDEE, ILL.—The town board of East Dundee has decided to submit the question of works to a popular vote, according to reports.

FARMINGTON, ILL.—Chas F. Sturtevant, Consult. Engr., writes us that the contract for an artesian well has been awarded to S. Swanson, Minneapolis, and that the city proposes to construct works as soon as possible after the development of the water supply.

APPLETON, WIS.—The council has voted to submit the question of supply, whether artesian or from the river, to the voters at the election this month.

LANCASTER, WIS.—The question of works is being agitated, according to press reports.

REEDSBURG, WIS.—C. C. Stevens, Cy. Clk., writes us that owing to an injunction now pending, and to the fact that more than $25,000 will be required, the question will have to be voted upon again by the citizens, and that this depends upon the new council.

BELLEVUE, IA.—W. G. Stuart writes us that the committee is now arranging with an engineer to make surveys and estimates for works; population, 1,000.

GRISWOLD, IA.—Bids are asked until April 19 for constructing works, including 6-in. well, 500,000-gallon pumping machinery, about 6,000 ft. 6 and 4-in. pipe, 9 hydrants, etc. Engrs., Andrews & Burrell, Fremont, Neb. D. H. Scott, Tn. Recdr.

SHELDON, IA.—It is reported that works will be put in.

DELANO, MINN.—A. L. Mealey, Cy. Recdr., writes us that the citizens will vote on the question of works and an electric light plant April 10, and that the question is quite sure of being carried; no plans yet prepared; estimated cost, $10,000; supply from river; population, 1,200.

CHANUTE, KAN.—J. W. Buchanan, Cy. Clk., writes us that the contract for works has been awarded to O. J. Gorman & Co., Dallas, Tex., at $41,500. The Iowa Const'n & Mfg. Co. bid $47,900, and G. Jeager, Rich Hill, Mo., $43,225.

BERTRAND, NEB.—It is reported that all the candidates for town offices are pledged to work for works.

CEDAR RAPIDS, NEB.—The city is reported as about to sell $9,000 in bonds for works.

TOBIAS, NEB.—The taxpayers have petitioned for a special election to vote on the question of works, according to reports.

KIRKSVILLE, MO.—J. W. Tinsman, mayor, is reported as stating that the city is ready to award contracts for works.

ST. JOSEPH, MO.—The commercial club is considering the question of better fire protection.

CAPE GIRARDEAU, MO.—A 20-year franchise has been granted to A. W. Gilbert and others.

HEWOPSTEAD, TEX.—Judge Lipscomb and A. C. Tompkins are interested in a proposed company to secure works.

FLORENCE, COLO.—A franchise has been granted Chas. J. Smith, Denver, for works, the system to be commenced within four months and completed within a year.

GLOBEVILLE, COLO.—A correspondent writes us as follows: After a careful examination of the supplies of the American Water-Works Co. and of the Citizens' Water Co., Denver, this town, a suburb of Denver, has concluded to pay 1 ct. more per 1,000 gallons and receive the pure mountain supply of the Citizens' Water Co. The contract is for the construction of a pipe system, consisting of 22,050 ft. of 4-in. pipe, 4,200 ft. of 6-in. and 5,280 ft. of 8-in. pipe, and 35 hydrants for the sum of $25,000 and the furnishing of water at the rate of 6 cts. per 1,000 gallons.

FRESNO, CAL.—The Fresno Water Co. is considering plans for the erection of a new stand-pipe tower, estimated to cost $20,000.

ARTESIAN WELLS.

CAMDEN, N. J.—The council has appropriated $5,000 for making experiments to improve the water supply, and it is stated that artesian wells will be sunk.

MILLINGTON, MD.—The citizens are raising money to secure an artesian well, according to reports.

GRISWOLD, IA.—Bids are asked until April 19 for sinking a 6-in. tubular well, wrought iron pipe tube, 80 ft. deep, to secure a daily supply of 500,000 gallons of water. D. H. Scott, Tn. Recdr.

CHAMPION, NEB.—Press reports state that residents of this place are planning to sink an artesian well to a depth of 1,000 ft.

IRRIGATION.

COLORADO SPRINGS, COLO.—The city engineer has prepared plans for a proposed ditch and reservoir in the northeastern part of the town; estimated cost of ditch, $12,600; reservoir, $20,000.

NEW COMPANIES.—Extension Stinson Ditch Co., Fresno, Cal.; $5,000; J. G. Janers, San Francisco; Joe Fax, Henry Watson and others.——West Etiwanda Land & Water Co., San Bernardino, Cal.; $50,000; H. C. Oakley, J. W. Oakley, Isaac Garbutt.——Sherwood Irrigation Co., Fort Collins, Colo.; $8,000.——Georgetown Irrigation Co., Georgetown, Idaho; $1,500.——Muskrat Lateral Ditch Co., Timnath, Colo.; $700.——Payette Canyon Ditch Co., Payette, Idaho; $100,000.

SEWERS.

BELFAST, ME.—L. H. March, Cy. Clk., writes us that plans for a complete sewer system for this city were made some years ago, but that only a small amount of the work is done each year. The mayor has recommended that about $4,000 be expended for sewers, the same as in 1893, but no definite action will be taken for two or three months.

PORTSMOUTH, N. H.—It is proposed to construct a 30 to 18-in. main sewer, 4,940 ft. long, and branch sewers at once, estimated to cost $26,000.

BEVERLY, MASS.—The council has voted to issue $100,000 in 4% bonds for sewer extension.

CONCORD, MASS.—A committee of five has investigated the question of a system, but C. E. Brown, Tn. Clk., writes us that nothing will be done at present, except to secure the necessary legislation.

HUDSON, MASS.—Plans are being discussed by the committee and M. M. Tidd, Engr., for a system. It is thought that the intermittent filtration system of sewage disposal will be used.

MEDFORD, MASS.—The commissioners have recommended an appropriation of $60,000 for sewers in seven streets.

NORTHAMPTON, MASS.—The commissioners have petitioned the council for an appropriation of $35,000.

NORTH ATTLEBORO, MASS.—Plans have been completed for a system for this place and Attleboro Falls, the downward intermittent filtration system of sewage disposal to be used; estimated cost, $67,707.

CENTRAL FALLS, R. I.—Bids are asked until April 10 for constructing about 3,000 ft. of pipe and 1,000 ft. of brick sewers. R. S. Dame, Secy. Comrs.

OLNEYVILLE, R. I.—Plans have been completed by J. E. Bowen for 36 to 15-in. brick sewers, to cost about $16,000.

BATAVIA, N. Y.—It is stated that the New York Central R. R. Co. is preparing plans for a system of drainage for its gravel pits near this place.

BROOKLYN, N. Y.—Bids are asked until April 12 and 13 for constructing sewers in two streets. A. T. White, Comr. Cy. Wks.

ITHACA, N. Y.—J. H. Fuertes, who has been engaged to prepare plans for a system, as stated March 22, has given the contract for a topographical survey of the city to J. F. Bradley and K. P. Crandall.

NEW YORK, N. Y.—Bids are asked by the department of public works until April 10 for building sewers in two streets.

BAYONNE, N. J.—It is proposed to construct a 48 to 36-in. brick sewer in several streets. W. C. Hamilton, Cy. Clk.

PATERSON, N. J.—The board of public works has voted to construct sewers in 11 streets.

TRENTON, N. J.—The clerk has been directed to ask for bids for the construction of a sewer in Rose St.

UNION HILL, N. J.—Plans have been prepared for a main sewer, to cost about $15,000.

WOODBURY, N. J.—D. T. Mathers, Cy. Clk., writes us that the question of sewers, noted March 22, has been referrred to the street committee to procure plans and estimates.

KITTANNING, PA.—Bids are asked until April 16 for constructing about 28,100 ft. of 30 to 8-in. pipe and 1,700 ft. of 51 to 32-in. brick sewer, as stated in our advertising columns. Engrs., Potter & Folwell, Pittsburg. G. R. Browne, Pres. Council.

LOCK HAVEN, PA.—E. P. Geary, Cy. Clk., writes us that Voorhees & Witmer have made plans for a system and that a portion of the work will probably be done each year, but that it has not been decided that any work will be done this year.

BALTIMORE, MD.—An ordinance has been passed appropriating $52,000 for a sewer in several streets.

SISTERVILLE, W. VA.—It is stated that the old council was re-elected with the understanding that contracts for sewers and paving would be let at once.

CLEVELAND, O.—The city engineer is to prepare plans for a main sewer in the east end, to be constructed jointly by the city and the village of Glenville.

DAYTON, O.—Plans have been prepared for lateral sewers in seven streets.

SANDUSKY, O.—The council has voted to construct sewers in two streets. A. W. Miller, Cy. Clk.

CRAWFORDSVILLE, IND.—The "Journal" urges that steps be taken at once towards the construction of a system.

EVANSVILLE, IND.—Bids are asked until April 14 for constructing a main sewer. E. E. Clarke, Clk. Bd. Pub. Wks.

TERRE HAUTE, IND.—Bids are asked until April 17 for constructing 12-in. pipe sewers in two streets. C. H. Goodwin, Cy. Clk.

BELLEVILLE, ILL.—The St. Clair Sewer Co. has been incorporated by Caspar Stolle, W. F. Stolle and Fred Dano; capital stock, $100,000.

CENTRAL PARK, ILL.—The contract for building the main Austin sewer, to cost $183,000, has been awarded in four sections by the Cicero town board. Joseph Duffy will build two sections and Tobin Hilliard and C. W. Menard one each.

MANKATO, MINN.—Contracts for sewers have been awarded to Kirkland & Starkey, St. Paul, at about $10,000, according to reports.

ANACONDA, MONT.—It is stated that the residents of East Broadway and East Granite St. are to petition for sewers on those streets; estimated cost about $15,000.

EVERETT, WASH.—A petition has been presented to the council to issue $100,000 in bonds for sewers.

SACRAMENTO, CAL.—An engineer is to be employed to make plans and surveys for a system, according to reports.

MONTREAL, QUE.—Bids are asked until April 11 for the construction of drains during 1894. P. W. St. George, Cy. Surv.

STREETS.

LOWELL, MASS.—Bids are asked until April 12 for furnishing from 50,000 to 400,000 granite edgestones and 2,000 lin. ft. of granite flagging. Geo. Bowers, Cy. Engr.

BROOKLYN, N. Y.—Bids are asked until April 10 for paving Leonard St. with cobblestones. A. T. White, Comr. Pub. Wks.

BUFFALO, N. Y.—The council has adopted plans for paving two streets with asphalt.

JAMESTOWN, N. Y.—It is reported that the contract for paving with brick, noted March 22, will probably be awarded to O. N. Gardner, at $88,000. The bids will be published next week.

NEW YORK, N. Y.—Bids are asked by the department of public works until April 10 for grading, etc., in 130th St.

NIAGARA FALLS, N. Y.—A resolution has been adopted to pave Main St. with brick or blocks.

PHILIPSBURG, PA.—It is reported that the property owners will1 petition the council to have Front St. paved with brick

REYNOLDSVILLE, PA.—It is proposed to pave four streets this summmer.

JACKSONVILLE, FLA.—It is proposed to pave nine streets with rock, two with clay, and four with brick.

PAINESVILLE, O.—Bids are asked until April 25 for 14,000 sq. yds. of brick paving, with 5,770 lin. ft. of Berea stone curbing. H. P. Sanford, Cy. Clk.

INDIANAPOLIS, IND.—Several additional streets are to be paved with asphalt, cement or stone.

DETROIT, MICH.—The board of public works has been directed to ask for bids for paving seven streets, estimated to cost about $61,600.

CHICAGO, ILL.—The Illinois Club has been discussing the proposed extending of Ogden Ave., estimated to cost about $2,500,000, including $692,948 for bridges and viaducts.

PEORIA, ILL.—Bids are asked until April 17 for furnishing curbstone during 1894. Jacob A. Harman, Cy. Engr.

MILWAUKEE, WIS.—The council has adopted resolutions for paving Grand Ave. and Jefferson St. with asphalt, to cost about $75,000, and North Ave. with cedar blocks.

WINNIPEG, MAN.—Bids will soon be asked for paving three streets with blocks, estimated to cost about $17,000.

VANCOUVER, B. C.—Bids are asked until April 13 for the sale of $72,356 of 5% 20-year local improvement bonds.

ELECTRIC LIGHT AND POWER.

MARBLEHEAD, MASS.—Plans and surveys are being made for a municipal electric light plant.

WELLSBORO, PA.—Hugh Young, L. Harrison, and others, have asked for a charter for the Wellsboro Electric Co.

SANDERSVILLE, GA.—An electric lighting plant is being discussed, according to press reports. Address Herman Bashinsky.

UPPER SANDUSKY, O.—The Citizens' Electric Light & Power Co. is reported as considering the advisability of adding an incandescent system, to cost about $5,000, to the plant.

EVANSVILLE, IND.—The department of public works has been authorized to ask for bids for putting in a municipal electric light plant. Fred Geiger, Jr., Cy. Clk.

SPRINGFIELD, ILL.—Bids are asked for the construction of a municipal electric light plant of 300 arc lights of 2,000 c. p. E. R. Taylor, Chn. Com.

LANCASTER, WIS.—The citizens are reported as discussing the question of electric lights.

WINNEBAGO CITY, MINN.—It is reported that an electric light plant will soon be put in.

OWATONNA, MINN.—A special election is proposed to decide upon issuing $15,000 in bonds for an electric light plant.

GRAND ISLAND, NEB.—The mayor suggests that the city put in an electric light plant in connection with the water-works; estimated cost, $10,000 to $15,000.

PAWNEE CITY, NEB.—It is reported that the citizens will soon vote on the question of buying an electric light plant.

NEW COMPANIES.—Peotone Electric Co., Peotone, Ill.; $6,000; H. A. Rathje, J. W. Stocker, John Fedde, Michael Collins.——Gallipolis Electric Light & Power Co., Gallipolis, O.; $18,000.——Chicago Heights Water, Light & Power Co., Chicago, Ill.; $100,000; H. L. Wallace, Homer Abbott, M. H. Kilgallen.——Springer Water & Electric Light Co., Springer, N. Mex.; $25,000; P. P. Tafoe, C. J. Marks, W. C. Lute, M. M. Salazar.——Citizens' Electric Light & Power Co., Hudson, N. Y.; $10,000; Hiram McGonegal, Sing Sing; S. D. Lake, A. J. Rowles, Hudson.——Ste. Genevieve Bangor, Pa.; $30,000.——Montclair Electric Light Co., Montclair, N. J.; $50,000; Paul Wilcox, F. G. Sullivan, J. A. Ryan, W. L. Ludlam.——Ohio Royal Arc Co.; $3,000,000; to operate at Plainfield, N. J., and Cleveland, O.; Albert Bellamy, A. H. Patterson, W. W. Dixon, New York; F. C. March, Elizabeth, N. J.

CONTRACT PRICES.

SCORIA BLOCK PAVING.—Montreal, Que.—A contract for paving with Scoria blocks upon 6 ins. of concrete has been awarded to the Sicilian Asphalt Co., at $1.79 per sq. yd. Percival W. St. George, Cy. Surv., writes us that these blocks are manufactured in England out of iron dross mixed with clay; that they are in the shape of brick, very hard and make good pavements.

DREDGING.—Cleveland, O.—The "Leader" states as follows: L. P. & J. A. Smith have sublet a contract to the Sheboygan Dredging & Docking Co., which will dig 350,000 yds. at Bar Point with a dredge now at work at South Chicago. The price paid for dredging at Bar Point is 18 cts. per cu. yd.—Breyman Bros., Toledo, have also sublet their Grosse Pointe contract, 300,000 cu. yds. each to C. H. Starke & Co., of Milwaukee, and Knapp & Dixon, of Racine, at 12½ cts. per cu. yd. The work is to be completed by 1895.

SEWERS.—Nelsonville, O.—L. E. Chapin, Consult. Engr., informs us that the bids for the proposed sewers ranged as follows: 4-in. pipe, laid, 28 to 60 cts. per lin. ft.; 6-in., 44 to 75 cts.; 8-in., 45 to 79 cts.; 10-in., 70 to 89 cts.; 12-in., 86 cts. to $1.20; 15-in., $1.10 to $1.53; 18-in., $1.60 to $2.30; 4-in. tile, 3 to 8 cts.; 6-in., 4 to 9 cts.; 8-in., 6 to 15 cts.; manholes, $34 to $57; flushtanks, $35 to $57; concrete, $5 to $7; lumber, $15 to $25; brick, per M., $6 to $13; rock, $2 to $5. The total bids were as follows: Zac. T. Darrow, Findlay, $24,028; J. W. Curry, Grafton, $35,821; H. C. Babbitt, Columbus, $23,799; J. M. Lamar, Nelsonville, $18,536; J. N. McNaghten, Grandview, $20 63; Myer & Perlds, Lancaster, $16,993; W. W. Cook, Fostoria, $21,515; Evans & Dunzweiler, Zanesville, 23,273; P. H. Kelly, Portsmouth, $21,621; Townsend & McCloud, Zanesville, $23,711.

PUMPING ENGINES.—Lebanon, Ind.—John W. Hill, Engr., Cincinnati, informs us that the following bids were received for two compound condensing duplex direct-acting pumping engines, each of 750,000 gallons daily capacity, together with two return tubular boilers and all appurtenances, the bid in the second column being for a non-condensing engine:

Laidlaw-Dunn-Gordon Pump Co.	$7,900	$6,400
Stilwell-Bierce & Smith-Vaile	6,730	5,840
Boughen Engineering Co.	8,050	6,720
Hughes Steam Pump Co.	7,880	6,100
Henry R. Worthington Co., New York	5,660	4,675*
Groshon High-Duty Pumping Engine Co.	8,950*	8,400*

* Without boilers.

WATER-WORKS.—River Falls, Wis.—Allen P. Weld Cy. Clk., writes us that the contract for constructing the proposed water-works has been awarded to Fairbanks, Morse & Co., at $17,960. The bids included the following prices:

	Pipe, per ton.	Hydrants, 5-in.	Valves, set. 10-in.	Total.
Fairbanks, Morse & Co.	$21.50	$37.50	$32.50	$17,960
P. V. Dwyer & Co.	20.50	35.00	29.00	20,874
Rinker & Hoff	22.00	37.50	32.50	20,760
E. T. Sykes	21.75	39.00	33.00	19,187
Tobin & Gleason	23.00	39.00	35.00	20,700
Foss & Bickler	23.50	40.00	35.00	22,825
U. S. Wind Engine Co.	22.40	42.00	37.00	19,469
Million & Young	....	33.50	31.75	19,100
Addyston Pipe & Steel Co	20.50	....	....	.....
R. D. Wood & Co.	....	37.00	....	.....
Waterous Engine Co.	....	35.00	....	.....

PIPELAYING.—Milwaukee, Wis.—The contract for laying water-mains during 1894 has been awarded to R. J. Hickey, at 23⅜ cts. per lin. ft. for 6-in. pipe, 29⅛ cts. for 8-in., 41⅞ cts. for 12-in., and 49⅞ cts. for 16-in. Last year the city paid 25½ cts., 32 cts., 44 cts., and 53 cts.

HYDRANTS.—Milwaukee, Wis.—The "Sentinel" states that a contract for 125 fire hydrants will be awarded to the Northwestern Wheel & Foundry Co., Minneapolis, at $27.24 each. The Filer & Stowell Co. bid $32.45, and R. D. Wood & Co., $32.90. The contract last year was awarded to R. D. Wood & Co., at $34.99.

STAND-PIPE AND PIER.—Lebanon, Ind.—John W. Hill, Consult. Engr., Cincinnati, informs us that the following bids were received for a steel stand-pipe, 20x80 feet, on a stone pier 30 ft. high and 22 ft. in diameter:

Steel stand-pipe.	
The Brownell Co., Dayton, O.	$2,745
The Harvey Boiler Wks., South Bend, Ind.	2,875
The Variety Iron Wks., Cleveland, O.	3,048
Reeves Bros., Alliance, O.	3,150
Springfield Boiler Wks., Springfield, Ill.	3,325
Lafayette Bridge Wks., Lafayette, Ind.	3,400
Miami Valley Boiler Wks., Dayton, O.	3,430
Cincinnati Architectural Iron Wks.	3,496
Columbus Bridge Wks., Columbus, O.	3,533
L. Schreiber & Co., Cincinnati, O.	3,642
R. F. Hawkins, Springfield, Mass.	3,683
Stacey Mfg. Co., Cincinnati, O.	3,749
Stand-pipe pier:	
Hiller & Nolan, Dayton, O.	3,711
Lafayette Bridge Co. (in con. with steel work).	3,600
John O'Connell, Hillsboro, O.	4,375

BRIDGES.—Columbus, O.—John J. Dun, Co. Surv., writes as follows: We received bids March 23 on a two-girder span bridge 28-ft. roadway and two 6-ft. sidewalks, live load of 100 lbs., with wood floor system. The total estimate of weight of bridge was 190,000 lbs. The lowest bid was by the Youngstown Bridge Co. for bridge complete and erected, $5,230. This figures at the rate of about 2.45 cts. per lb., deducting the cost price of floor. On March 26 we received bids on another bridge similar in character to this, including two girder spans, wood floor system, steel joist, each span being about 75 ft. long, the total estimate weight of which was 150,000 lbs. The Youngstown Bridge Co. was also the lowest bidder for this structure, at $3,930 for the bridge complete and erected, or at the rate of 2.42 cts. per lb. for the finished iron work erected, after deducting the price of lumber. These bridges are to be built four or five miles out of our city, and will consist of two girders with floor beam resting on the lower flange of each

girder, the girder dividing the sidewalks from the roadway, except on the bridge upon which bids were received March 26, which has no sidewalks. The plans were prepared complete in my office by Herbert Knopf and Walter Braun, deputies. It has always been customary in this office to prepare our own plans, and we have only awarded one bridge in the last four years on any other plan than the one prepared by the county engineer's department.

RESERVOIR.—Nelsonville, O.—The successful bid received for constructing the proposed water-works was published last week under Contract Prices. L. E. Chapin, Consult. Engr., Canton, informs us that the bids for the reservoir were as follows:

	For 1,300 cu.yds. earth excavation.	2,000 yds. rock excavation.	220,000 brick laid.	500 sq. yds.conc. lining.	Roof & woodwork complete	100 ft. pipe. laid.	270 ft. gutter laid.	650 sq. ft. cement plaster.	Total.
T. C. McLain	.60	$1.45	$19.85	$1.17	$1,268.95	$221.50	$29.70	$0.46	$10,519.25
Rosser & Dawson, Bellaire	.25	.85	13.00	3.50	868.00	125.00	27.00	.08	5,538.00
Kelly Plumb. & H. Co., Columbus	.25	.90	15.00	1.00	1,450.00	90.00	67.50	.80	8,112.50
Coons & Darrow, Findlay	.20	1.00	13.00	.60	1,625.00	200.00	40.50	.40	7,581.50
Shaw, Kendall & Co., Toledo	.28	1.00	15.00	1.25	1,800.00	25.00	81.00	1.00	8,920.00
John Hill, Nelsonville	..	...	....	...	.....	.....	....	...	7,900.00

CURBING.—Fall River, Mass.—Contracts for curbing have been awarded as follows: Fall River Granite Co., 4,000 lin. ft., at 68 cts. per lin. ft., and Wm. Beattie, 6,000 lin. ft., at 70 cts., for jointed stone to be delivered on the street where wanted; Dunbar Bros., Sullivan, Me., 4,000 ft., at 44 cts., for split stone to be delivered at the wharf.

MANHOLE CASTINGS.—Malden, Mass.—The contract for furnishing manhole frames and covers for the sewer department for 1894 has been awarded to the Concord Foundry Co., at $5.23 each, the other bids being as follows:

Sessions Foundry Co	1.43 cts. per lb.	$5.79 each
Condor Iron Foundry Co.	1.49 " "	6.03 "
Mechanics Foundry Co	1.52 " "	6.15 "
Osgood & Hart F'dry Co.	....	5.80 "

SPEEDWAY.—New York, N. Y.—The following bids were received by the department of public parks March 30 for constructing the section of the proposed speedway between High Bridge and Dyckman St., the bid for the first section of the work being published in our issue of Feb. 1:

BIDS RECEIVED FOR THE SECOND SECTION OF THE PROPOSED SPEEDWAY, NEW YORK.

	J. J. Hopper.	J. D. Leary.	Thos. Nevins & Son.	Broadhead & Hicky.	J. C. Rodgers.	Flynn & Ryan.	Isaac A. Hopper.
Excavation, 210,500 cu. yds.	$1.20	$0.62	$1.00	$1.10	$1.20	$1.05	$1.00
Filling, 380,000 cu. yds.	.30	.22	.60	.20	.15	.20	.25
Dredging, 350,000 cu. yds.	.25	.344	.24	.29	.30	.25	.18
Rock excavations, below water, 2,000 cu. yds.	15.00	6.00	14.50	11.50	8.00	7.00	10.00
Crib-bulkhead, 3,775,000 cu. ft.	.055	.057	.06	.06	.045	.05	.055
Broken stone in foundations, 1,200 cu. yds.	1.70	1.40	2.00	1.90	2.00	1.50	.80
Rip-rap in foundations, 7,000 cu. yds.	.70	.60	1.00	1.15	1.00	.65	1.00
Concrete, Rosendale cement, 200 cu. yds.	4.10	5.00	5.00	5.20	8.00	5.00	5.40
Concrete in foundations, Port. cem., 1,300 cu. yds.	5.40	8.00	7.50	7.85	10.00	7.00	7.00
Rubble masonry, Rosendale cement, 1,400 cu. yds.	3.00	4.00	4.50	5.00	5.00	6.50	5.00
Broken range masonry walls, 760 cu. yds.	6.75	9.00	8.00	8.50	10.00	7.50	8.00
Coursed granite in retaining walls, Rosendale cement, 220 cu. yds.	12.00	17.00	15.00	18.50	27.00	15.00	9.00
Granite coping on retaining walls, 670 lin. ft.	3.35	4.40	4.00	6.25	5.00	5.50	3.00
Coursed ashlar granite mas., Port. cem., 700 cu. yds.	30.30	26.00	25.00	19.85	27.00	30.00	9.00
Granite arch masonry, Portland cement, 90 cu. yds.	92.60	78.00	40.00	30.00	40.00	50.00	20.00
Brick masonry in arches, Rosendale cem., 160 cu. yds.	8.50	15.00	10.00	12.00	12.00	10.00	8.00
Dry rubble masonry in slope walls, 500 cu. yds.	2.00	3.00	2.50	3.10	2.00	2.50	2.70
4-ft. brick culverts, 1,310 lin. ft.	9.50	7.70	10.00	9.45	7.00	8.00	10.00
10-in. pipe culverts, 1,400 lin. ft.	.80	1.00	1.25	1.05	.75	1.00	.75
12-in. pipe culverts, 1,070 lin. ft.	1.00	1.10	1.40	1.25	1.00	1.30	1.00
18-in. pipe culverts, 680 lin. ft.	1.60	1.65	2.20	2.00	1.25	1.80	1.75
Receiving basins, complete, 18	150.00	120.00	200.00	147.00	90.00	140.00	200.00
Gutter outlets, complete, 12	25.00	40.00	40.00	45.00	25.00	25.00	35.00
Walk inlets and gratings, complete, 26	15.00	20.00	30.00	32.00	15.00	30.00	15.00
Piles driven and left in foundations, 36,000 lin. ft.	.20	.24	.24	.26	.18	.25	.20
Timber and plank, furn. and laid in found., 80,000 ft.	35.00	40.00	40.00	38.00	30.00	35.00	35.00
Yellow pine timber in platforms, steps, etc., 12,000 ft.	35.00	100.00	42.00	40.00	40.00	50.00	45.00
Sandy loam r'dway, broken stone and cinder found., incl. trap-block pav. in gutters, 63,500 sq. yds.	.75	.60	1.00	.66	.50	.79	1.10
Rock asphalt pavement, rubble stone and Portland cement concrete foundation, 93,000 sq. ft.	.20	.24	.25	.20	.25	.27	.25
Gravel walk, rubble stone found., 190,000 sq. ft.	.10	.12	.125	.09	.05	.10	.06
Cobble-stone pavement in gutters at foot of slopes, 1,700 sq. yds.	.56	1.00	.95	1.20	.40	1.00	.50
Curbstone, fine axed, 6 × 22 ins., 12,900 lin. ft.	1.00	1.30	1.35	1.00	.85	1.15	1.25
Bluestone coping, incl. concr. found., 3,300 lin. ft.	3.50	4.00	4.50	3.00	2.75	3.50	4.00
Granite coping on steps and walks, 600 lin. ft.	3.60	4.00	6.00	6.25	3.00	5.50	2.50
Granite steps furnished and set, 1,500 lin. ft.	2.30	3.65	6.00	6.25	1.75	2.50	2.00
Total amounts	$890,654	$779,084	$1,031,428	$869,678	$751,240	$812,450	$812,000

BRICK PAVING.—Atlanta, Ga.—The following bids were received for paving Pryor St., 18,000 sq. yds., with vitrified brick, and also for constructing all brick pavements ordered by the council for 1, 2 or 3 years; Venable Bros., $2.56 per sq. yd. for Pryor St. and $2.35 for work for three years; Virginia Paving & Const'n Co., $2.36 and $2.32; Tennessee Paving & Brick Co., $2.50 and $2.40; Standard Paving Co., $2.19 and $2.24; Howard Neely, $2.08 and $2.16; M. E. Maher, $2.17 for Pryor St.

Quincy, Ill.—E. R. Chatten, Cy. Engr., has sent us a statement of the bids received for paving three streets with one course of brick upon 6 ins. of broken stone and 3 ins. of sand, with limestone curbing. The contract was awarded to the Winona Construction Co., Winona, Minn. The bids were as follows, 1 being for paving, per sq. yd.; 2, curbing, per lin. ft.; 3, resetting old curb, per lin. ft.:

	1.	2.	3.
Henry Rees, Quincy	$1.32	45 cts.	5 cts.
A. Mayfield, Lincoln	1.47	47	25
Winona Const'n Co., Winona, M.	1.20	43	10
J. H. Frick, Dixon, Ia.	$1.53 and	1.55	53	13
W. F. Hummert & Bro., Quincy.	1.31	48	6
Henry Hummert, Quincy	1.34	48	12
Wm. Grewe, Quincy	1.29	46	8
Mull & Doon, Aurora	$1.52 and	1.55	50	19
W. J. Berry, Bellaire, O.	$1.31¾ and	1.33¾	44	20
T. J. Shea, Quincy, Ill.	$1.55 and	1.60	free	free
N.P.Glahn Const'n Co., Galesb'g	1.32½	42	25

Keokuk, Ia.—A contract for paving with St. Louis and Spaan brick has been awarded to Cameron & McManus, at $1.49 per sq. yd.; curbing, 57 cts. per lin. ft.; resetting old curbing, 10 cts.; grading, 37 cts. per cu. yd.; total amount, $14,219. Wm. West bid $14,595.

Huntington, Ind.—Contracts for paving with brick have been awarded as follows Jefferson St., Adam L. Beck, at $1.75 per sq. yd. for paving, 54 cts. per lin. ft. for sandstone curbing and 60 cts. for circular curbing; Market St., Keefer & Hallwood, $1.65, 55 cts. and 65 cts., respectively.

BRICK.—Lowell, Mass.—Geo. Bowers, Cy. Engr., writes us that the contract for hard and burned sewer brick has been awarded to Edward Cawley, Lowell, at $7.25 per M., the other bids being as follows: C. J. Cheney, Lowell, $7.35; Connors Bros., Lowell, $7.65; Granite State Brick Co., Epping, N. H., $8.75; Geo. V. Simpson, Suncook, N. H., $7.35. The bids for sewer pipe were not made public, by request of the bidders.

ASPHALT PAVING.—Jersey City, N. J.—The following bids were received last week for paving with asphalt, the bidders being: 1, (Mrs.) A. H. Shannon; 2, Trinidad Asphalt Paving Co.; 3, Barber Asphalt Paving Co.:

	1.	2.	3.
Paving over Belgian blocks	$2.20	$2.91	$2.69
" " cobble stones	2.15	2.91	2.73
" " macadam	2.30	2.91	2.73
" adjacent to car tracks	2.25	2.91	2.75

Montreal, Que.—A contract for paving with 2 ins. of asphalt on 6 ins. of concrete has been awarded to the Sicilian Asphalt Co., at $3.93 per sq. yd. It is stated that similar work last year cost $3.49 per sq. yd.

RAILWAY SUPPLIES.—St. Louis, Mo.—The following lowest bids were received for constructing the switch along the water-works conduit: Cahill, Collins & Co., 588 tons of steel rails, at $24.90 per ton; Wilson & Block, switch ties, at $1.60; Berthold & Jennings, 16,590 crossties, $5,857. The latter are to be of beech, elm, maple and black oak, according to press reports.

WATER-WORKS SUPPLIES.—Richmond, Va.—E. E. Davis, Secy. Water Com., writes us that the following contracts have been awarded: Southern Railway Supply Co., Eddy fire hydrants, at $21.25 each; Eddy valves, 4-in., at $6.25; 6-in., $11; 8-in., $17.25; 10-in., $24.50; 12-in., $33; 16-in., $60; 20-in., $100; pig lead, 3¾ cts. per lb. Smith-Courtney & Co. bid for Ludlow hydrants and valves, in the order given above, $22, $6.65, $11.05, $17.35, $24.90, $31.55, $59.20, $100; West & Branch, for Chapman hydrants and valves, $22.35, $8.94, $13.77, $20.44, $31.12, $42.23, $23.28, $137.86; and Geo. B. Gaines & Co. for the Kennedy hydrants and valves, $26.28, $5.94, $8.91, $14.85, $19.30, $26.73, $24.90, $93.50. The contracts for cast-iron pipe, 4 to 36-in., was awarded to the Anniston Pipe & Foundry Co., at $17.70 per ton. Smith-Courtney Co. received the contract for ½-in., ¾-in. and 1-in. tapping cocks, at 39 cts., 48 cts., and 75 cts. each, respectively; ¾-in. corporation cocks, at 59 cts.; 1-in., 90 cts.; ⅝-in. stop cocks, at 34 cts; ¾-in., 42 cts.; ⅞-in., 74 cts.; 1¼-in., $1.12; jute packing, at 5¼ cts. The contract for excavating trenches was awarded to W. F. Fletcher, at 25 cts. per cu. yd. for clay streets and 27 cts. for gravel.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

LEVEE WORK.—Memphis, Tenn.—Press reports state that Capt. Townsend, U. S. Engineer Office, will award contracts this month for about 750,000 cu. yds. of work.

DRAINAGE.—St. Charles, Mo.—H. C. Lackland has been elected president and H. Plackemeier secretary of the Big Ditch Association, formed to drain several thousand acres of land northwest of this city.

DAM IMPROVEMENTS.—Galena, Ill.—The contract for widening the government dam in the Mississippi River 12 miles south of this city, opposite Belvedere, Ia., has been awarded to Bigelow & Teasdale, La Crosse, Wis. The work will include the construction of a wagon road across the dam, according to reports.

CANALS.—Leesburg, Fla.—A canal 1¼ miles long is projected between lakes Harris and Griffin. Address J. H. C. Pratt.

Rockledge, Fla.—A. S. Lee is president of the Rockledge Canal Co., which has been formed with a capital stock of $10,000 to excavate a canal one-half a mile long and 8 ft. deep across Merritt's Island to the Banana River.

BUILDINGS.—Bismarck, N. Dak.—Bids are asked at the office of the state auditor until April 9 for the erection of a four-story, 50 × 100-ft. addition to the state capitol.

Duluth, Minn.—The lowest bids for the construction of the new board of trade building were: Butler Bros., Duluth, at $135,700, and M. P. Ryan, St. Paul, at $136,000. Bids on iron work, electrical work, etc., will bring the total cost of the building to about $250,000.

RACE TRACKS.—Chicago, Ill.—C. N. Loucks, Agt., has purchased 125 acres of land at Barrington, 30 miles northwest of this city, where it is proposed to construct the fastest race track in the world. The plans are said to call for an expenditure of $150,000. Hawley Bros., Barrington, are interested.

Springfield, Ill.—The grounds committee of the state board of agriculture have approved the specifications of Engineer Rickart for the construction of a full mile driving track for the state fair. The secretary will advertise for bids and the work will be commenced as soon as possible.

INDUSTRIAL NOTES.

THE HALL SIGNAL CO., of New York, N. Y., has a contract to erect the Hall automatic signal system between Albany and Saratoga, on the Delaware & Hudson R. R.

THE INDIANA STEEL CO. has been organized by Pittsburg and Chicago men, with a capital stock of $100,000, and it is proposed to establish a steel plant at Frankton, Ind.

THE SCHENECTADY LOCOMOTIVE WORKS, of Schenectady, N. Y., have completed an eight-wheel express engine for the New York Central R. R., similar to the well-known record-breaking engine No. 999.

CARS.—L. K. Hirsch, Rookery Building, Chicago, has purchased 140 miles of the East End & Red River Railway, and is selling the narrow gage cars, locomotives and other equipment of the road.

THE BALL & WOOD CO., of Elizabethport, N. J., has completed a 600-HP. compound engine for the Chicago Edison Electric Co. It is of the vertical inverted cylinder (marine) type, with flywheel between the two cranks, and the valve gear is driven by two sets of bevel gearing.

THE AMERICAN STEEL CASTING CO., which was recently incorporated in New Jersey with a capital stock of $4,200,000, has absorbed the Norristown Steel Co., of Norristown, Pa.; the Standard Steel Casting Co., of Chester, Pa.; the Sharon Steel Casting Co., of Chester, Pa.; the Solid Steel Co., of Alliance, O.; the Syracuse Steel Foundry Co., of Syracuse, N. Y., and a majority interest of the capital stock of the Pittsburg Steel Casting Co. The purchase of the various plants was made, with one exception, by the respective stockholders agreeing to exchange their stock for that of the American Steel Casting Co. The exception was the Standard Steel Casting Co., of Chester, which was bought outright. The new company will, it is said, introduce economies which will enable the business to earn a profit even at the present low prices. The directors are: Jos. H. Bohl, president of the Solid Steel Casting Co.; Daniel Egan, president of the Sharon Steel Casting Co.; Frederick Fraser, president of the Syracuse Steel Foundry Co.; Augustus Trump, secretary and treasurer of the Pittsburg Steel Casting Co.; G. J. Humber, manager of the Norristown Steel Co., and Henry Weston, of New York, and Charles N. King, of Jersey City.

NEW COMPANIES.—New York & Chicago Ferris Wheel Co., New York; $600,000; G. W. G. Ferris, of Pittsburg, Pa.; Andrew Onderdonk, of Chicago, Ill., and Wm. G. Bussey, of New York, N. Y.——A. B. Frame Water Wheel Co., Muscatine, Ia.; $100,000; A. B. Frame, Wm. Hyde and G. A. Funck.——Gagnier-Griffin Suspended Railway Bridge Co., Chicago, Ill.; $1,000,000; George Mason and G. H. Griffin.——National Lead Mining & Smelting Co., Chicago, Ill.; $500,000; G. H. Griffin and James C. Baird,

METAL MARKET PRICES.

LEAD.—New York: 3.4 to 3.5 cts. Chicago, 3.25 to 3.3 cts. St. Louis, 3.15 to 3.22 cts.

NAILS.—Pittsburg: 95 cts. to $1 for wire and 95 cts. for cut at mill.

FOUNDRY AND PIG IRON.—New York: $12 to $13.50. Pittsburg: $10.50 to $11.75. Chicago: $10.75 to $12.25.

TRACK MATERIAL.—New York: angle bars, 1.25 to 1.4 cts.; spikes, 1.65 to 1.8 cts.; track bolts, 2 to 2.1 cts. with square and 2.2 to 2.3 cts. with hexagon nuts. Chicago: angle bars, 1.4 cts.; spikes, 1.75 to 1.8 cts.; track bolts, 2.4 to 2.45 cts. with hexagon nuts.

RAILS.—New York: $24 to $25 at eastern mills and at tidewater; old rails, $12 for iron and $10 for steel; light rails, $24 to $26; girder rails, $24 to $25. Pittsburg: $24 for standard sections. Chicago: $25 to $27; old rails, $10 for iron and $8 to $9 for steel.

STRUCTURAL MATERIAL.—New York: beams, 1.3 to 1.5 cts.; channels, 1.3 to 1.5 cts.; angles, 1.2 to 1.35 cts.; tees, 1.4 to 1.6 cts.; universal mill plates, 1.15 to 1.35 cts.; steel plates, 1.2 to 1.3 cts. for tank, 1.35 to 1.4 cts. for shell, 1.55 to 1.6 cts. for flange, 1.75 to 2 cts. for ordinary firebox; 2 to 2.25 cts. for locomotive firebox. Pittsburg: beams, 1.15 to 1.25 cts.; channels, 1.15 to 1.25 cts.; angles, 1.1 to 1.2 cts.; tees, 1.25 to 1.35 cts.; universal mill plates, 1.1 to 1.2 cts.; steel plates, 1.1 to 1.2 cts. for tank, 1.3 to 1.4 cts. for shell, 1.5 to 1.6 cts. for flange, 1.75 to 4 cts. for firebox. Chicago: beams, 1.35 to 1.4 cts.; channels, 1.35 to 1.4 cts.; angles, 1.35 to 1.4 cts.; tees, 1.5 to 1.6 cts.; universal plates, 1.3 to 1.35 cts.; steel plates, 1.35 to 1.45 cts. for tank, 1.7 to 1.8 cts. for shell, 1.6 to 2 cts. for flange, 2 to 5 cts. for firebox.